COCKPIT VIDEO

A LOW COST BDA SOURCE

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE

COCKPIT VIDEO A low cost BDA Source

5. FUNDING NUMBERS

N/A

6. AUTHOR(S)

LT COL KEVIN W SMITH, USAF

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

CADRE/PT
MAXWELL AFB AL 36112-5532

8. PERFORMING ORGANIZATION REPORT NUMBER

AU-ARI-93-1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

SAME as #7

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

N/A

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

PUBLIC RELEASE

12b. DISTRIBUTION CODE

A

13. ABSTRACT *(Maximum 200 words)*

14. SUBJECT TERMS

15. NUMBER OF PAGES
75 plus

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLAS	UNCLAS	UNCLAS	NONE

Research Report No. AU-ARI-93-1

Cockpit Video

A Low Cost BDA Source

by

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December 1993

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This publication has been reviewed by security and policy review authorities and is cleared for public release.

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Foreword

Lieutenant Colonel Smith's study is timely and important as it addresses the overlooked role attack aircraft onboard video recordings played in the Gulf War. His study delineates the steps we should explore institutionalizing the onboard video products in both the bomb damage assessment (BDA) and intelligence areas.

This research offers the potential of enormous (hundreds of millions of dollars) savings if onboard video can satisfy a greater percentage of our BDA needs. Additionally, Lieutenant Colonel Smith's proposal to turn all attack aircraft into collection platforms is certainly worth exploring.

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About the Author

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Lt Col Kevin W. Smith graduated from the United States Air Force Academy in 1975 with a degree in physics. Following undergraduate pilot training at Reese Air Force Base (AFB), Texas, fighter lead-in at Holloman AFB, New Mexico, and F-4C Replacement Training Unit (RTU) at Luke AFB, Arizona, he was assigned to the 428th Tactical Fighter Squadron (TFS), Nellis AFB, Nevada.

Transferring overseas, Colonel Smith had follow-on assignments in the F-4 with the 80th Tactical Fighter Squadron at Kunsan Air Base (AB), Korea, and the 313/10 TFS at Hahn AB, Germany. While stationed at Hahn AB, he transitioned to the F-16, completed a masters degree in management, graduated from Fighter Weapons School, and became a wing weapons and tactics officer for the 50th Tactical Fighter Wing (TFW).

Returning from overseas, Colonel Smith was the 310th Tactical Fighter Training Squadron's (TFTS) weapons officer at Luke AFB, Arizona. While at Luke AFB, he transitioned to the F-16C, served as a 312th TFTS flight commander, and the 832d Air Division's chief of inspections and evaluations. Colonel Smith departed Luke AFB in 1988 for Air Command and Staff College (ACSC) at Maxwell AFB, Alabama, where he concurrently completed a degree in mathematics.

After ACSC, Colonel Smith requalified in the F-16 at MacDill AFB, Florida, and became the Headquarters United States Air Forces Europe (USAFE) F-16 Weapons and Tactics Division staff officer at Ramstein AB, Germany. In addition to his USAFE staff duties, he maintained flying currency with the 496th TFS, Hahn AB, and the 480th TFS, Spangdahlem AB, Germany. While serving on the USAFE staff, he was selected as the 1992–93 command-sponsored research fellow.

Acknowledgments

I gratefully acknowledge the research and editorial assistance I received from Dr Lawrence Grinter, Dr Glenn Morton, and Ms Melrose Bryant. A special thanks goes to the following officers who went to extra effort on my behalf: Col Jim Brechwald, Lt Col Bob Eskridge, Lt Col Pat Gandee, Lt Col Dan Leaf, and Lt Col Tom Nowak.

My family deserves special mention for their patience and understanding of the long hours. My wife, Dorothy, contributed hundreds of hours of "free" word processing, criticism, and encouragement.

Introduction

Chairman of the Joint Chiefs of Staff Gen Colin Powell confidently announced to the press on 17 January 1991, "We are rating 80 percent [of our air sorties] as having been effective, meaning the aircraft got to its target, delivered its ordnance, and returned."[1] The following morning in Riyadh, Saudi Arabia, Gen Norman Schwarzkopf stated, "We're doing absolutely everything we possibly can in this campaign to avoid hurting . . . innocent people."[2] Due to limited battlefield accessibility, lack of military expertise, and material withheld for operational security, the press was very reluctant to accept the military's claims. As one reporter commented,

> We're finding a conflict in information. The last couple of days, I've heard 80 percent successful on bombing raids. I keep hearing this figure. Unfortunately, none of us here are seeing that information you're seeing which tells you it's 80 percent successful. When can the media, and directly, when can the American people plan to see a bomb damage assessment, meaning planes smashed on the ground, bunkers torn up, airfields torn up, supply facilities torn up, in unclassified photos or gun camera. . . ? It's not to say I'm unconfident [sic] about it, but unless I can see it first-hand, I'm disinclined to believe . . . you.[3]

On 19 January 1991, Lt Gen Charles A. Horner, commander of US Air Forces, Central Command (CENTAF), proudly declared, "We couldn't have taken a pickup truck and laid those bombs out there any more accurately."[4] He graphically supported his claims with F-111F and F-117A cockpit videotape segments, showing direct hits on an airfield and his counterpart's headquarters in Baghdad.[5] Due to years of mistrust and acquisition horror stories, the press was only temporarily satisfied and continued to demand more proof.

Over the next couple of days, the military was unsuccessful in satisfying the media's requests for detailed information to corroborate coalition success. The lack of bomb damage assessment (BDA) began to generate frustration and suspicion throughout the press corps, as seen in the following reporter's question:

> They won't discuss the detail, even if targets have been destroyed, they won't discuss them in general, and it's very hard to evaluate the claims that this operation is proceeding as you [sic] had planned in the absence of any information . . . specific, general, whatever . . . about what you've accomplished.[6]

Lt Gen Thomas Kelly responded to the press by stating "We are having difficulty with bomb damage assessment due to the weather."[7] This was the first public admission of actual bomb damage assessment problems. By 21 January 1991, a skeptical press had made the BDA shortfall a major news controversy. Assistant Secretary of Defense for Public Affairs Pete Williams tried to quell the issue on several occasions.

> In terms of bomb damage assessment, I sense frustration here that we haven't been more forthcoming about bomb damage assessment. Let me tell you that there is [a] frustration level all over the building about what bomb damage assessment is. . . . This sort of inter-

pretation of this data is an art, not a science; it requires good weather, which we've not a lot of in terms of bomb damage assessment the last few days.[8]

The press began to use the term *bomb damage assessment* for all aspects of combat assessment, as well as a measure of military competency. Follow-on attempts to explain the combat assessment process to the media were unsuccessful, because the broader connotation for bomb damage assessment had become ingrained. In addition to the press notoriety, bomb damage assessment was considered by virtually every war-fighting commander as inadequate. Secretary of Defense Dick Cheney stated in the Title V Report to Congress that BDA was one of the major areas we need to improve.[9]

The entire BDA intelligence process had decayed since Vietnam, requiring Desert Storm units to develop work-around procedures during combat to satisfy their BDA needs. Dedicated BDA assets like Vietnam vintage "strike" cameras had been replaced by video tape recording (VTR) systems. These VTR systems were acquired piecemeal and fielded principally for training purposes, not combat assessment. However, it was these onboard cockpit sensor and visual display recordings that provided Desert Storm units and CENTAF planners with information timely enough to efficiently conduct the air campaign. Ultimately, units ended up relying heavily on their own organic onboard attack aircraft cockpit video to provide bomb damage assessments. Some units directly credited onboard video recordings as one of the principal "keys to success" during Desert Storm.[10]

Unfortunately, war-fighters' reliance upon onboard video has not been fully recognized, credited, or documented. Additionally, doctrinal guidance, acquisition requirements, and intelligence procedures for assessing and reporting onboard fighter aircraft-derived information are lacking. In order to preserve the BDA lessons relearned in Desert Storm, a proper role for onboard video needs to be documented and institutionalized to prevent "reinventing the wheel" during the next conflict. That is the purpose of this study.

Scope

This research can not address all the BDA problems experienced during the Gulf War, as time and classification would preclude such an analysis. Instead, it will focus on unit level war-fighting interfaces, particularly those to which onboard video was a key contributor.

Methodology

The first chapter examines Desert Storm BDA problems, root causes, and work-arounds developed to compensate for the lack of timely bomb damage assessments. Additionally, problems with postwar analysis of munitions effects are addressed.

The chapter concludes with a look at the status of attack aircraft onboard video and why decision makers resorted to using it during the war.

Chapter 2 explores the evolution of fighter aircraft film/video and their historical role in combat assessment. It starts with the lessons learned in World War II and follows the building of BDA structures during war and their subsequent decay during peacetime. The chapter concludes with a look at the status of the armament recording program.

Chapter 3 is in two parts. The first section breaks down and examines specific uses of attack aircraft onboard video during Desert Storm. The second section explores the doctrinal and procedural issues that need to be addressed to fully incorporate onboard video in the intelligence and BDA processes.

Chapter 4 is a general survey of potential onboard video enhancements that could be pursued to further expand the utility and effectiveness of onboard video-derived information.

Chapter 5 is a brief synopsis of the BDA issue and contains specific recommendations for institutionalizing onboard video in BDA and intelligence processes.

Notes

1. Office of the Assistant Secretary of Defense for Public Affairs Operation Desert Storm press transcipts, 17 January 1991 through 15 March 1991, 3.

2. Ibid., 2.

3. Ibid., 10.

4. Ibid., 3.

5. Ibid.

6. Ibid., 11.

7. Ibid.

8. Ibid.

9. Department of Defense, *Conduct of the Persian Gulf War: Final Report to Congress*, chaps. 1–8, April 1992, i–xxviii.

10. Thomas P. Christie, "After-Action Report for the Operation Desert Shield/Desert Storm Technical Data Directory Project," January 1992, II-2.

Chapter 1

Desert Storm Bomb Damage Assessment Issues

Accurate damage assessment is especially important. To ensure strategic attacks produce the desired effects, commanders must not only procure accurate intelligence beforehand, they must also persistently assess and reassess the effects of their actions and the reactions of the enemy.

—Air Force Manual 1-1, *Basic Aerospace Doctrine of the United States Air Force*, volume 2

Gen Colin Powell proclaimed, "No combat commander has ever had as full and complete a view of his adversary as did our field commander. Intelligence support to Operations Desert Shield and Desert Storm was a success story."[1]

> In no other conflict in American history have tactical commanders corps-level and below, been able to call on as capable an intelligence system as in the Gulf War. Yet, despite the impressive capabilities of collections systems at the national, theater, and tactical levels, many division, brigade, and wing commanders expressed frustration and dissatisfaction with the intelligence support they received. The detail desired in some cases, was, and will continue to be, beyond the capabilities of the intelligence system.[2]

In fact, accuracy of Desert Storm intelligence estimates, and in particular bomb damage assessment, was the single most controversial issue within the armed services during the entire air campaign. Combat commanders at the tactical level of war criticized BDA for being too slow and insufficient to meet their needs. At the operational level of war, national assets often took days to produce results that were required within hours.[3] The unprecedented demand for imagery, BDA, and tactical intelligence far exceeded the amount of information required during the Vietnam War and outstripped the capabilities of today's state-of-the-art intelligence systems.[4]

The secretary of the Air Force expressed his frustrations with inadequate BDA and acknowledged the prominent role fighter aircraft onboard video tape recordings had played when he asked the following: "Was, in fact, the air campaign achieving the levels of destruction that planners had hoped and that videotapes seemed to indicate?[5] US Air Forces, Central Command (CENTAF) intelligence personnel did not expect onboard fighter aircraft video to play a significant role in the BDA process. They planned to rely on external imagery reconnaissance systems for BDA. However, these reconnaissance systems were not able to supply timely or sufficient BDA and, as a result, onboard video tape recordings became a vital source of BDA.

This chapter will examine Desert Storm BDA problems, the causes of those problems, and work-arounds generated to compensate for BDA inadequacies.

Bomb Damage Assessment Problems

Bomb damage assessment may be summed up quite simply: too little and too late. Some of the major problems are discussed in this section.

Insufficient and Not Timely

Bomb damage assessment results were not timely enough for CENTAF planners to make efficient restrike decisions.[6] External reconnaissance assets did not always provide mission results to commanders and decision makers in time to avoid redundant restrikes or preclude unnecessarily risking valuable aircraft and aircrew.[7]

The fast-paced air campaign required timely BDA results to complete the daily air tasking order (ATO).[8] While the ATO was quite successful in the preplanned stages of the air campaign, it was less responsive as operations progressed.[9] The ATO planning cycle was too quick for the CENTAF BDA process, particularly for operations against mobile targets. "Target selection and planning often were nearly completed before results of previous missions were available."[10] As a general characterization, BDA produced by national systems was a minimum of a day old and not timely enough for the ATO process.[11]

> Operation Desert Storm validated again the requirement for timely dissemination of intelligence to the tactical level. However, system capabilities, coupled with the lack of communications capability or systems, did not meet tactical commanders' expectations—either in quality or quantity.[12]

Tactical commanders required more detail than CENTAF was able to produce, and the lack of vital information impacted negatively on targeting and unit-level decision making.[13] "Frequently, tactical units were sent finished estimates and summaries produced for senior commanders rather than the detailed, tailored intelligence" needed for tactical operations.[14] Additionally, commanders felt the information flow was a one way direction and left them in a position of having inadequate intelligence.[15] As a result, tactical commanders became highly critical of the entire BDA process.[16]

Not Prepared for Quantity or Tempo

With a BDA system essentially dormant since Vietnam, the sheer number of bombs dropped and the rapid tempo of air operations outstripped the process established for collecting and reporting intelligence. Additionally, the battlefield introduction of large quantities of precision guided munitions (PGM) created a significantly higher demand for BDA than in past wars. This quantity and accuracy increase complicated the intelligence collection strategy, slowed BDA analysis, and delayed reporting.[17]

During the Vietnam War, an entire attack package was frequently required to strike a single target to achieve sufficient target damage. A single poststrike photo would often suffice for analysis. Today, with more accurate conventional systems and precision guided munitions, multiple targets can be effectively attacked by a single aircraft. The result is an exponential increase in the number of individual bomb damage assessments required for each wave of attack aircraft. For example, one attack package of 20 F-111F aircraft armed with four laser guided bombs, making two passes each on an airfield, could conceivably deliver two precision guided bombs on 40 separate targets. For this one F-111F attack package, 80 separate impact points would need to be assessed to determine the degree of damage. The tempo of this attack would average a precision guided munition impact every five seconds over the span of seven minutes.[18] The pace of the air campaign and quantity of bombs dropped vastly exceeded the ability to collect, analyze, and distribute adequate BDA.[19]

Not Suited for Mobile Targets

The pace and volume of ordnance dropped against small mobile targets in Desert Storm was staggering compared to previous wars. Damage to mobile targets was very difficult to determine. With extended distances to the battlefield, external reconnaissance assets were expected to supply tactical intelligence and BDA.[20] But frequently both national and tactical reconnaissance systems were unable to determine if attacked tanks and armored vehicles were operable.[21] Today's antiarmor munitions make small and potentially lethal penetrations that are difficult to detect and assess. Analysts were not sufficiently trained to perform this type of BDA.[22]

> Unless the destruction was catastrophic, a destroyed tank might still appear operational. . . . In short, the BDA system was called upon to produce results it had not been asked for in the past. . . . [Consequently,] targeting at the theater and tactical levels was less effective in the absence of more precise damage assessment.[23]

The result was the inability to determine accurately if mobile targets had been rendered inoperable, unless they were catastrophically damaged. Additionally, there was also the possibility mobile targets could have been counted more than once. Attrition counts were key measures of campaign progress and helped determine the timing for the ground offensive.[24] Once the ground campaign began, commanders needed almost real-time information to facilitate tactical decisions, a need which further taxed the BDA system.

Not Prepared for Precision Guided Munitions

The revolutionary combination of stealth aircraft and PGMs allowed a nearly simultaneous parallel attack against scores of targets across the entire Gulf theater.[25]

> [However,] analysts were unable to meet the requirements for timely data on a variety of new types of targets or targets struck in new ways. For example, the

> precise targeting and striking of sections of buildings or hardened shelters complicated the assessment process.[26]

Because of the accuracy of precision guided munitions and the ability to render a facility inoperative with the destruction of a single strategic component, each weapon delivered essentially required imagery for assessment.[27]

Complicating the analysis process was the lack of weaponeering experience for penetrating munitions. "Even some of the better imagery analysts had difficulty assessing degrees of damage for targets not catastrophically destroyed."[28] Hardened bomb cases created only a small exterior entry hole and provided little evidence of internal damage. These munitions would characteristically detonate inside aircraft shelters or hardened bunkers, effectively destroying the contents inside. Even with catastrophic effects inside hardened facilities, internal damage was difficult to assess from poststrike imagery alone.[29]

> Aggravating the overall BDA efforts was a CENTCOM J-2 structure that initially did not include its own independent BDA cell. Further, when the theater cell was formed, it relied solely on the current Joint Munitions Effectiveness Manual (JMEM) for such assessments and did not have direct access to expert opinion or sophisticated methods to make predictive calculations regarding effects of penetrating PGMs.[30]

In many cases, an attack aircraft video recording showing a direct hit with subsequent secondary explosion(s) would be the most accurate indicator of attack success.

> While there will never be enough information to satisfy all levels of command, improvements are clearly needed to ensure that BDA capability keeps up with the ability to strike targets with precision and penetrating weapons.[31]

Documentation Lacked Detail/Correlation

BDA provides an essential source of data for identifying weapons deficiencies, fuze reliability, target vulnerability, optimum delivery tactics, delivery accuracy, and planning adequacy.[32] Individual target and munition assessments provides data for target system analyses, reconstitution estimates, weaponeering, and restrike requirements.[33] This same data also supports many levels of follow-on testing and analysis, fundamental in balancing competing resources and determining overall force levels. During combat operations this information is extremely perishable if not meticulously documented and preserved.

During Desert Storm, there was a vast amount of information generated to support combat operations. Unfortunately, due to the lack of a detailed plan to document, preserve, and archive this data, a lot of information perished.[34] Very few units adequately documented their combat operations on a mission by mission basis. Additionally, much of the available information that was preserved cannot be easily converted or correlated to support a comprehensive analysis.[35] For example, only 77 percent of Desert Storm units had a complete record of their munition expenditures.[36] The 37th Fighter Wing (F-117s) was

one exception—recording much of its information in a commercially acquired data base. Also, air tasking orders and mission reports (MISREP) did not provide the detail or specifics required to correlate and evaluate weapon delivery systems or individual weapons. Much more complete and accurate information is required to support combat assessment.[37]

Merely acquiring more imagery is not necessarily a solution to BDA shortfalls.

> During the air campaign DIA [Defense Intelligence Agency] analyzed only a very, very small percentage of the available imagery, [and then] for a limited target set. These limited BDA efforts, in response to daily "critical target" tasking from CENTCOM, taxed DIA's assets. To analyze even one image can require hours of study by a highly skilled imagery interpreter. It would be an enormous task for DIA to [now] attempt to analyze all available imagery for all targets in the area of operations and enter the data into an electronic data base.[38]

One of the lessons we failed to retain from the Vietnam War was the need to meticulously document and preserve weapons delivery information for follow-on analysis. It may take hundreds of thousands of man-hours just to clean up, correlate, and analyze the data that is available. Much of this ongoing, after-the-fact work could have been prevented with proper planning for data collection.

> [In the future] the quality of these assessments can be improved by using other sources such as on-board video . . . or re-evaluating the imagery with knowledge of which weapons were used. More accurate BDA needs to be produced to fully examine the effects caused by weapons systems.[39]

For the F-111F and the F-117A units, their efforts to record and preserve each mission's data on a videotape will greatly enhance future effectiveness studies of their weapon and delivery platforms.[40] Other weapon systems and munitions effectiveness studies will suffer due to the lack of sufficient documentation. There is a definite need for a process to record and store the information required to conduct follow-on combat assessments.[41]

BDA Disagreements

Considerable dissension resulted, during and after the conflict, on the differences in BDA estimates provided by various agencies within the theater and national sources.[42] These agencies, many participating for the first time in new wartime functions, produced duplicate and frequently contradictory intelligence products.[43] This problem was mentioned during the conflict by Gen Norman Schwarzkopf in the following press statement:

> . . . 38 airfields have all been struck at least once, and many of them have been struck at least 4 times, at least 9 of them are non-operational. . . . There have been varying reports about how many of these airfields have been destroyed, and there have been varying reports about how much damage we've done on the ground.[44]

The Central Intelligence Agency (CIA)- and DIA-generated BDA data and associated intelligence assessments conflicted significantly with those produced in-theater.[45] For example, an F-15E crew member reported he typically

would have a photo taken within 24 hours showing the target was destroyed and then receive a CIA or DIA message stating the target was still operational.[46] General Schwarzkopf testified at a Senate Armed Services Committee hearing,

> Intelligence facts that we had were helpful, the analysis that we received was unhelpful, and it was unhelpful because it ended up being so caveated—there were so many disagreements within the intelligence community themselves—there were so many disclaimers.[47]

Assessment problems stemmed from an enduring intelligence belief that outside agencies are better able to determine BDA from photographs than from pilot reports.[48]

At the tactical level, unit commanders wanted more specific information to make the rapid decisions necessitated by the quick pace of the war.

> The national-level intelligence structure, including the National Intelligence Council, DIA, and CIA, adhered to the peacetime concept of competing analysis, [sic] which gives intelligence consumers the benefit of alternate views and predictions. This is appropriate for high-level policy makers; however, to a combat commander, this reporting method often presents too broad a picture and too wide a range of options to affect combat force posturing or employment.[49]

The lack of imagery, tactical intelligence, and BDA at the unit level created a significant element of distrust in the intelligence process. As a result, many units began to create their own internal methods of acquiring and assessing BDA.[50] Units principally relied on their organic onboard aircraft sensor or heads up display (HUD) video recordings to provide them with timely BDA.

Weighting Disagreements

> Had General Schwarzkopf not believed his air campaigners, he might have unnecessarily endangered the lives of his aircrews. . . . He was convinced of the success of the air campaign, and his timely action prevented unnecessary [or] wasted sorties.[51]

One of the biggest questions of the Gulf War was when to start the ground offensive. As a result, a great deal of contention arose from the diversity of estimates for obtaining a tactical battlefield BDA estimate.[52] For example, US Army Forces, Central Command (ARCENT)

> used A-10 pilot reports, aircraft videos, and high resolution imagery. We counted one third of the pilot reports that labeled targets as destroyed, one half of the aircraft videos, and all reports of destruction from imagery. . . . Aircraft videos worked well, but we deleted half of the apparent kills because subsequent imagery generally confirmed only about that amount destroyed. Emotion arose from two disparate sectors. On one hand, the Air Force believed our BDA was too conservative. On the other hand, national intelligence agencies, using national imagery largely, claimed our BDA was too liberal. They estimated enemy strengths at 80 to 90 percent a few days before G-Day, when we assessed them to be approaching 50 percent.[53]

Intelligence agencies devised "ad hoc" methodologies to estimate the strength levels of Iraqi forces, because no method existed to evaluate onboard

video for modeling force attrition.[54] The consequence of using too lenient or too strict video weighting either unwarrantedly risks air assets or prematurely commits ground assets. There is a pressing need to develop onboard video assessment methodologies to accurately assess attrition levels.

Causes

Combat assessment inadequacies stem from a complicated mix of shortfalls in the areas of collection, processing, interpretation, and dissemination.[55]

No Standardized Terminology

Historically, combat assessment was divided into bomb damage assessment, munitions effects assessment (MEA), and mission assessment (MA).[56] However, during Desert Storm the term *bomb damage assessment* was so widely used for all aspects of combat assessment, particularly by the press, that the specific meaning is now blurred even within the Air Force. Combat assessment terms are not defined in either AFM 11-1, *Air Force Glossary of Standardized Terms,* or Joint Pub 1-02, *Department of Defense Dictionary of Military and Associated Terms.* To complicate matters, there has been no delineated combat assessment process either in the Air Force, Army, or participating Department of Defense (DOD) agencies.[57] Currently, the DIA is coordinating a standardized BDA terminology (appendix A) and trying to establish mutually understandable and functional terms.[58]

In addition, standardized damage descriptions and categories are also being developed (appendix B). This is designed to preclude another instance of a four-span bridge being reported as only 50 percent damaged when two spans have been dropped into a river.[59] It is worth noting that in some of the proposed new physical damage categories, attack aircraft onboard video assessments are considered "essential" in determining damage levels.[60]

Dependence on National Systems

> *Surveillance and reconnaissance performed by space-based platforms operating in the atmosphere provides information needed to plan and direct the operations of combat forces.*
>
> —AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* volume 2

Desert Storm may have been the "first space war," but many war-fighting commanders complained their basic BDA needs were not met.[61] Even though no other military conflict has ever had the advantage of such quality of reconnaissance imagery, military commanders were clearly not satisfied.[62] After years of being told national and theater intelligence sources would provide all the information needed when the time came, commanders at all levels had high expectations.

> In recent decades, intelligence of great value to military commanders has been obtained through signals intercepts and overhead photography that by necessity are collected at some remove from their operational areas. The collection, analysis and dissemination of such technical intelligence has employed large bureaucracies (most located in the Washington area), which have been set up to provide information to various parts of the Federal Government. These types of intelligence are referred to as "national" intelligence since more than one agency or department is involved.[63]

In the past, national agencies have responded to Washington-level policymakers on strategic level issues and have not been overly concerned about the needs of combat commanders.[64]

Desert Storm commanders required information on a near-real-time basis. This near-real-time support was provided only on a very restrictive basis and was not always as timely as military commanders desired or needed.[65] Target imagery frequently lagged by days, not just hours.[66] Commanders wanted near-real-time information to determine the effectiveness of their air strikes and an accurate accounting of Iraqi combat forces.[67] Additionally, national agencies were not prepared for the magnitude of information required for modern warfare. For example, the invasion of Kuwait generated more than 2,700 separate intelligence requests, compared to the 166 information requests the national military intelligence support processed during Operation Just Cause.[68]

> Intelligence provided to ground tactical commanders from the theater and national levels was not always timely and often came in unfamiliar formats. In confronting these difficulties, commanders often generated additional requests for information which, in turn, further taxed the overburdened theater and national intelligence systems. Consequently, ground tactical commanders were not confident with the tactical intelligence picture as G-Day approached.[69]

Hence, tactical commanders at division and wing levels considered the support of national systems as insufficient. Many felt we had become overreliant on national and theater systems and as a consequence were lacking unit-level imagery and BDA support.[70]

Weather

General Schwarzkopf reported to Congress, "Unless [a target] could be seen on a photo as absolutely, 100 percent being destroyed, no credit was given for it being destroyed."[71] But abnormally bad weather in Iraq and Kuwait resulted in severely hampering imagery-acquired BDA.[72] Lt Gen Thomas W. Kelly made the following comments to the press about Desert Storm weather problems.

> We know we have done some damage. We've had weather problems over the past three days. As a matter of fact, as I looked at a picture just before I came down here, all of southern Iraq, all of Kuwait, and the northern part of Saudi Arabia are heavily covered by clouds. We've had a lot of fog problem[s]. We are fighting the bomb damage assessment problem as hard as we can, and the minute that we get better information and I'm authorized to release it . . . we will. We do know that we have done damage. We can't tell completely the extent of that damage.[73]

During periods of poor weather, units relied on their own onboard video recordings to determine attack effectiveness.

Nationally Controlled BDA Assets

When you give the CINC the responsibility to fight [a] war, you've got to give him the intelligence support. Too much of our intelligence support is retained on a centralized basis.

—Lt Gen Charles A. Horner
Air Force Times, January 1992

Technological enhancements have improved the ability of national intelligence to support war fighters, but due to large bureaucracies, the national intelligence community has emphasized its support of peacetime missions over combat commander's needs.[74] While CENTCOM and DIA did work closely coordinating the various intelligence elements, national collectors only "optimized" CENTCOM intelligence requirements.[75]

General Schwarzkopf criticized national systems for responding to Washington's direction and not the theater commander's. He requested a new military system be fielded to provide real-time products to the theater commander.[76] However, continuous coverage of every inch of Iraq and Kuwait would require a cost-prohibitive number of satellites.[77] Even if we were able to increase the volume of national asset imagery, the resultant processing would require a significant increase in the number of analysts.[78] In a period of declining defense expenditures, a large increase in the number of reconnaissance systems is unlikely.

Limited Tactical Reconnaissance Assets

We must have adequate reconnaissance to fight a successful war.

—General Matthew B. Ridgway (1954)

The primary mission of tactical reconnaissance (Tac Recce) has been to satisfy the needs of combat commanders, so timely decisions for targeting and restrike can be made.[79] The Gulf War again demonstrated to tactical commanders the ready availability and responsiveness of tactical reconnaissance assets to the theater commander. In order to compensate for the lack of BDA, tactical reconnaissance aircraft were tasked to film more targets than normal per sortie. Since only limited tactical assets were available to deploy to the Gulf, RF-4Cs were required to cover 50–80 targets per day.[80] Aircrews had difficulty planning tactically sound missions requiring "ten to fifteen targets versus the normal three to four."[81] This frequently necessitated more lengthy target area maneuvering than would have been otherwise possible if we did not have total air supremacy.[82] The permissive environment also allowed the U-2R and TR-1 to be more effective since they were able to overfly target areas to collect data.[83] Even in this permissive air environment, the demand for imagery and imagery-derived products could not be met.[84] With the drawdown

of the RF-4C and the retirement of the SR-71, insufficient tactical reconnaissance assets increased the demand on national reconnaissance systems.

The House Intelligence Committee concluded the acquisition of tactical collection platforms had not kept pace with the modernization and capability increases of the rest of the force.[85] While RF-4Cs and other reconnaissance systems provided a significant contribution to the BDA effort, tactical customers were not satisfied with the overall level of imagery support. Additionally, in future conflicts, total air supremacy and the level of threat suppression we enjoyed in Desert Storm may not be as easily attained.[86]

A Dated BDA Process

> *Without the ability to "see over the next hill," the effective use of military power becomes nearly impossible to plan or execute.*
>
> —AFM 1-1, vol. 2

While the intelligence support to CENTCOM was considered a success overall, the BDA effort was not.

> The BDA process at the theater level suffered from a lack of adequate systems, procedures, and manpower and had difficulty trying to keep pace with the size, speed, and scope of the air campaign. Not since Vietnam had the DOD Intelligence Community been faced with such a large scale BDA challenge.[87]

Exercising the bomb damage assessment process in peacetime is not easy and as a result has been allowed to atrophy.[88] Since Vietnam, revolutionary changes in delivery accuracy and widespread use of precision guided munitions has necessitated a new level of information for planning, delivery, and analysis. Instead of needing to identify a building complex containing the target, now we must identify the specific room in which the key component is located.[89] Additionally, BDA analysts were unprepared for the quantity of individual weapon assessments required and the difficulty of assessing penetrating munitions.[90]

The intelligence community has long been leery of the objectivity of pilot "heat-of-the-moment" postmission claims, since the first bombs were dropped off an aircraft in World War I.[91] Korean War pilot BDA claims were viewed by some as exceeding the actual damage by as much as a 30:1 ratio.[92] Hence, the intelligence community has been predisposed to distrust the accuracy of MISREPs, insisting on external photo confirmation.[93] Entering Desert Storm optical imagery was still considered by the intelligence community as the legitimate source of BDA.[94]

> The desire not to overstate operational accomplishments led to assessing damage based only on what could be proven using [external] imagery. In some cases, this seems to have precluded making rapid judgments about what probably had been accomplished. This practice did not serve well the needs of the commanders operating under combat time pressures. They could not wait for in-depth analysis; decisions had to be made based on judgment. Consequently, planners were forced to make their own assessments of how attacks were succeeding, and whether restrikes were needed. In addition, some agencies doing BDA did not have some

> essential planning data, such as, the desired aimpoint, weapon destruction information, the target list priority, or the desired damage level.[95]

Prior to Desert Storm the capability of onboard attack aircraft video systems was essentially overlooked by the intelligence community. Intelligence personnel rarely viewed aircrew videotapes except for drawing radar predictions for radar bomb scoring (RBS) folders. As a result, CENTAF BDA personnel were not prepared to fully utilize the results of onboard video-acquired information and predisposed to use only external reconnaissance imagery to confirm target damage.

This reliance on external imagery was excessively restrictive and resulted in erroneous restrike decisions.[96] Additionally, the BDA architecture had to essentially be recreated for Desert Storm, and not all facets of it were tested or synchronized with the attack planning process in time for combat operations.[97] BDA procedures in which information is posted the following day are no longer suitable for the tempo of today's warfare.[98] Consequently, planners and decision makers relied heavily upon onboard video-derived information, because external imagery was unable to deliver sufficient BDA within the time constraints for effective use of air assets.[99]

Poor Secondary Imagery Dissemination

"Although national and theater imagery reconnaissance platforms could collect substantial amounts of imagery, getting it to the tactical commander proved difficult."[100] Tactical commanders felt the imagery available to them was totally inadequate. Even imagery produced in-theater was not readily available to combat units.[101] Testifying before the Senate Armed Services Committee, General Horner said,

> in every other war when our pilots were to go out and to hit a target, they generally have an aerial photograph in their lap that was no more than 24 hours old of exactly what it was that they were going to hit . . . therefore, as the battlefield changed, they were up to date on the changes that occurred in the battlefield We didn't have that capability in this [war], and that's what we mean by [lack of] tactical intelligence.[102]

Acknowledging the need for secondary intelligence dissemination, the new draft intelligence doctrine states, "standards for interoperability, such as the National Imagery Transmission Format (NITF), should be developed and incorporated into intelligence systems and equipment."[103] However, no single-source document specifies onboard video standards and interoperability requirements.

MISREP Inadequacies

MISREPs lacked standardization and the required detail to utilize fully onboard video-derived information. Some units accomplished MISREPs in considerable detail while others simply stated "successful."[104] Even within the same unit, some MISREPs were considerably more detailed than others. Some MISREPs mentioned "video assessed" results, while others made no

mention of how the damage or results were determined. One unit just assumed CENTAF knew their BDA was taken from aircraft video. In many cases, the only way to discern if MISREP information was gleaned from postmission analysis of cockpit video recordings was if the debriefer took the time to annotate a "VTR assessed" footnote.[105] The wide variance in MISREP quality and detail is indicative of the lack of regulation guidance and training.[106]

Operations procedures and unit caveats to onboard video results also varied considerably. The F-111F unit was one of the strictest as they directed their pilots to report a "miss" if their mission could not be positively verified by postflight onboard video review, even if they saw their munition(s) impact the target.[107] There is currently no guidance on how to assess onboard video, document the results, or report other information of intelligence value derived from onboard video. This shortage of detailed guidance highlights the lack of emphasis placed on unit-derived intelligence and onboard video acquired information.

ATO Omissions

As previously described, there is insufficient information available for follow-on combat assessment, in terms of quantity and quality of BDA, to conduct thorough follow-on weapon-effects assessments.[108] Shifting weaponeering decisions to the unit level through extensive use of tasking "best available" ordnance, resulted in significant postconflict assessment correlation problems. Lack of knowing the munition, fuze, and, in some cases, the desired mean point of impact (DMPI) complicated imagery analysts' BDA assessments.[109] Additionally, postmission reports failed to rectify these shortcomings as they did not document actual fuze type, setting, or delay element employed.[110] These omissions resulted in BDA difficulties during the war and is still causing ongoing combat assessment problems.

Intel's Reluctance to Use Onboard Video

> *In combat and other critical situations, the intelligence needs as seen by the commander should outweigh otherwise valid management objectives of intelligence efficiency.*
>
> —Joint Test Pub 2-0, *Doctrine for Intelligence Support to Joint Operations*

Targeting personnel generally do not use raw intelligence to make targeting decisions and were reluctant to accept onboard video as a valid source of BDA.[111] When the lack of BDA started to impact the air campaign, Guidance Apportionment Targeting (Black Hole) personnel quickly resorted to cockpit video as their principle source of campaign BDA.[112] Initially, there was little or no correlation of onboard video results with the CENTAF intelligence process.[113] Intelligence personnel were not trained for aircrew video tape analysis and units were not fully equipped for processing and assessing videotapes for BDA information.

> Another deficiency was the scarcity of trained video data interpreters in the theater. At US Air Force Central Command [CENTAF] there were only two trained target intelligence officers assigned to video tape review. In any event the requirement to review all aircraft videotapes at one location might be unsupportable.[114]

Over time, onboard video-derived information gradually began to receive a wider degree of acceptance within the intelligence community, particularly for determining the attrition levels of mobile targets.[115]

> Ultimately, CINCENT relied upon a synergistic approach to determine BDA across the board and within individual target categories. He meshed BDA assessments from the DIA and other national agencies and tactical reconnaissance . . . with mission reports . . . and gun camera imagery to provide a balance[d] assessment of the air campaign.[116]

While video results needed to be calibrated they were indispensable in measuring ground force attrition.[117]

BDA Work-arounds

> *Reflecting that American 'can do' spirit, the campaign included some remarkable examples where plans were improvised, work-arounds were found, and new ways of operating were invented and rapidly put into practice.*
>
> —*Conduct of the Persian Gulf War: Final Report to Congress*

Desert Storm personnel circumvented the intelligence system because the BDA system was not providing them with what they needed. Theater-controlled photographic reconnaissance systems partially filled the gaps "but suffered from weather outages and built-in reporting delays for film processing and delivery."[118] MISREPs were about an entire day behind, so Black Hole planners resorted to talking directly to the units and using telephonically passed onboard video results to determine mission success and restrike nominations.[119]

> Planners assumed more of the current operations tasks, improvised to work around BDA shortcomings, and developed a system to track the multitude of adjustments and changes to avoid unnecessary restrikes.[120]

The resulting BDA process was a combination of objective and subjective analysis to determine damage levels, attrition rates, and follow-on tasking.[121]

Initially video results were earmarked for the media to demonstrate coalition success. However, due to the lack of timely BDA, onboard cockpit video provided a key source of campaign information and BDA.[122] Brig Gen Buster Glosson established courier flights to transport onboard video to the Black Hole on the third day of the war. For the remainder of the conflict a daily C-21 shuttle picked up F-117A videotapes at Khamis Mushait and F-111F videotapes at Taif and delivered them to Riyadh. F-15E videotapes were also delivered daily to Riyadh from Al Karj by ground transportation.[123] "Throughout the war, damage assessment and intelligence information to support decisions to restrike particular targets were piecemeal affairs, requiring individual users, whether on a Carrier or in Riyadh, to synthesize assessments

independently."[124] Ultimately, all services made extensive use of courier systems to work around the inadequacy of traditional sources of BDA.[125]

After the first few days, units were expected to pick many of their own DMPIs in accordance with their commander's intent.[126] BDA was rarely provided to the units and occasionally when units did receive BDA it was too dated to be useful.[127] The US Navy viewed the bomb damage assessment problem as

> a constant frustration at the squadron level, just as it was [at] higher headquarters. Unless clear target effect [sic] could be seen (i.e., secondary explosions), the BDA was usually reported by the flight leader as "unknown." Even after the arrival of the F/A-18D Fast-Facs, accurate estimates of effect on [the] target were hard to come by—even when the back seater carried binoculars. The best BDA occurred when a wingman's [onboard video] camera caught the leader's impacts. However, this was a relatively rare opportunity and pilots were admonished not to take unnecessary chance[s] in their target attacks just to get [a] good BDA tape. [Additionally,] Remotely Piloted Vehicles (RPV) rarely gave BDA that was usable at the squadron level. They were quite useful for locating targets, but they rarely were used for BDA.[128]

Unit-level planners and targeteers of all services resorted to unit-derived onboard video, pilot reports, and organic intelligence assets to conduct BDA and mission planning.[129]

Video in the BDA Process

Although improved dissemination of national and theater imagery and intelligence can meet some of the Desert Storm BDA shortfalls, better use of aircrew onboard video recordings could contribute significantly to solving the BDA problem. Commanders, aircrew, and intelligence personnel believe much more could have been done with onboard video if units and intelligence personnel had been prepared to use video to its full potential. Due to the lack of procedures, training, and exposure to onboard recording devices, little was done to further exploit onboard video during the war. For example, infrared sensor video was rarely used for information other than on the intended target.[130]

While targeteers and analysts struggled with discerning the weapons effects of PGMs, systems like the F-111's Pave Tack had the capability to provide an immediate damage assessment.[131] In certain situations, only onboard video was able to determine bomb damage effects accurately. For example, a small hole on the side on a shelter might be missed, when the attack aircraft's videotape clearly showed a secondary explosion.[132]

Further, video was poorly used to correlate munition impacts, fuzing, and other important parameters for postconflict weapons assessment. Many units were required to reuse videotapes of previous missions due to the lack of a sufficient supply of blank videotapes.[133] Fighter units are negligent in not acquiring a supply of blank videotapes as part of their war reserve materiel (WRM) kits. The 48th Fighter Wing established a comprehensive video library, which proved to be a significant and highly valuable source of intelligence. It also

had the foresight to (creatively) acquire sufficient videotapes to document and preserve the entire F-111F effort. Additionally, previously flown mission videotapes were cataloged and stored for premission study of follow-on missions to the same target area.[134]

Onboard video clearly established its viability for supporting the BDA effort in Desert Storm. Units relied on their own onboard video recordings to generate campaign BDA, as it was not supplied on a timely enough basis from external sources. Mobile target attrition counts were highly dependent upon onboard video assessments. Overall, onboard attack aircraft video recordings were an integral part of Desert Storm BDA.

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Chapter 2

Evolution of Fighter Film/Video

Toward the end of World War II, President Franklin D. Roosevelt directed the formation of a team to survey strategic bombing to determine the effects of the Allied bombing campaign against Germany. This team found it necessary to follow closely behind the front to prevent vital information from being irretrievably lost.[1] The study highlighted the difficulty in acquiring and fully understanding the damage inflicted on enemy forces and the need to prioritize scarce collection resources to conduct BDA.[2] It also identified the shortage of trained intelligence personnel to conduct the volume of minutely detailed and accurate work required for a complete analysis.[3] However, after the war many of the findings of this commission were considered irrelevant as the United States had entered the nuclear era, where conventional wars were thought to be obsolete. Throughout the next 38 years, the USAF would struggle to build a BDA process during wartime and then allow it to decay during peacetime.

This chapter explores the evolution of onboard film and video in the bomb-damage-assessment and intelligence processes. The gradual elimination of onboard strike cameras resulted in an Operation Desert Storm reliance on video systems fielded for training purposes.

1950s High-Altitude Reconnaissance

While trying to quell the Desert Storm BDA criticism, Under Secretary of Defense for Public Affairs Pete Williams told a press audience that the Korean War BDA was not "even done until it was over."[4] His basic premise was essentially correct. BDA during the Korean War was rarely timely and much of the weapon effects analysis was done well after the fighting.

> Many times the B-29s had to attack targets without the aid of current surveillance photography and in some cases BDA photography was not received until weeks after a strike was made. In March 1953, for example, Bomber Command did not get bomb damage assessment (BDA) photos of the Taeyudong ore processing area until a month after its attack.[5]

Once B-29s became vulnerable to attack from the newly introduced MiG-15s, most of the daylight bombing in North Korea was conducted by tactical jet aircraft. Without the World War II massed bomber raids on large industrial targets, specific targeting information became vital to ensure effective

use of fighter assets. Lack of strategic targets and North Korean efforts to rebuild previously struck targets created an enormous demand for tactical intelligence and BDA. Intelligence personnel had difficulty coping with the "massive amounts of information, redundant reporting, and the need for rapid reaction."[6] Analysts struggled with devising a workable methodology of assessing weapon effects and categorizing their associated levels of destruction.

World War II bombers routinely carried cameras for target photography, but fighter aircraft used in the Korean War were equipped only with forward-looking gun camera film. Fighter missions had to rely upon other aircraft to provide target photographic reconnaissance for BDA. Additionally, the quality of early photographic reconnaissance imagery was poor. The Air Force experimented with many different camera systems during the war, and the quality of imagery gradually improved.

The intelligence focus after the Korean War was high-altitude reconnaissance for nuclear employment, and the Korean War combat assessment infrastructure essentially disappeared in the rapid postwar demobilization. With American concentration on the emerging Soviet nuclear threat, little thought was given to fighting another conventional war.

1960s Rapid Fielding of "Strike" Cameras

As the USAF expanded its air support to South Vietnam, the need for conventional BDA was quickly recognized. Initial air-to-ground missions required a great amount of tactical information, reminiscent of fighter operations in Korea. Deployed forces made an urgent request for a photographic system to provide "documentary, strike, and reconnaissance photographic coverage."[7] Field commanders wanted a flexible system capable of being used in a wide variety of operational situations to provide tactical intelligence as well as imagery.[8] Basic gun camera systems were not capable of adequately documenting weapon effects because of poor fidelity and the inability to record bomb impacts.[9] Tactical Air Command (TAC) responded quickly to these requests by expediting the testing and fielding of strike camera systems.[10] Special air warfare units already deployed to Vietnam were given first priority for combat documentation system upgrades. Operation Farm Gate B-26K, A-1E, and T-28Cs were the first aircraft to be outfitted with strike camera systems.[11]

Once B-26K aircraft were successfully equipped with KA-60 strike cameras, testing was initiated on a new panoramic camera that would provide horizon-to-horizon coverage for high-speed aircraft.[12] Fighter aircraft strike cameras were deemed an absolute necessity to record target run-in, bombing approach, ordnance release, and provide a general assessment of ordnance effectiveness.[13] The following mission-need statement for the KA-71A camera delineates these requirements and highlights a broader intent to use strike camera film for both intelligence acquisition and historical documentation.

> The KA-71 strike camera will provide over-the-target film documentation by obtaining run-in, target vertical development, ordnance release and impact, and strike assessment photography. It is anticipated that a large amount of "new" intelligence will be revealed upon detailed review of this photography. Operations and intelligence will utilize these photographs to determine weapons delivery accuracies, evaluate tactics and techniques and as an aid in the improvement of pilot proficiency. Secondarily, photographs taken by the KA-71 strike camera will be utilized to document the air war.[14]

Each special air warfare and fighter unit was to be equipped with its own film development capability. These supporting film laboratories were intended to be self-contained and deployable.

Strike Cameras in Jet Fighter Aircraft

As the war escalated, aircraft modification programs were initiated to install the Fairchild KA-71 and KB-18 panoramic strike cameras on Vietnam-bound jet fighter aircraft.[15] The KA-71 panoramic strike camera was mechanized so that when the pilot actuated the weapons-release circuitry (pickle button), the camera began to film the area directly in front of the aircraft. The camera had a gimbaled attachment to allow the camera to swing aft, parallel to the aircraft's fuselage, to film the area along the route of flight (appendix C).[16] Then, as the aircraft passed over the target, the camera would lock, facing aft, to film ordnance impact. The camera film control was set with a predetermined overrun time to permit the camera to film long enough to record weapon effects. Unfortunately, the KA-71 panoramic camera results periodically suffered degradation because the camera was restricted only to sweeping aft along the fuselage. This limiting factor required the pilot to be wings-level throughout the entire maneuver to achieve satisfactory results. In combat, a steady wings-level recovery maneuver was not always possible due to enemy defenses.[17]

Even with its inherent limitations, strike camera products were widely used in all fighter operations. Strike camera results were utilized for a number of purposes to include rapid assessment of mission results, retasking decisions, acquisition of intelligence, detection of equipment/weapons malfunctions, and to identify faulty aircrew delivery techniques.[18] By the end of the war, strike camera operations were an integral part of each squadron's campaign planning, mission planning, employment, and analysis.

Camera Pods

Concurrently with th fielding of strike cameras, several still and motion reconnaissance pod ca era systems were developed and fielded for use in Vietnam.[19] These podded systems were mounted on external weapons stations to provide poststrike results and reconnaissance imagery for analysis. Unfortunately, externally mounted camera systems reduced the number of ordnance stations available for munitions and also resulted in an aerodynamic penalty. Additionally, these expensive camera assemblies would be jettisoned whenever the aircrew had to react to ground defenses or enemy

fighters.[20] The Air Force experimented with photographic pods to further enhance reconnaissance throughout the war; however, units disliked flying with them.

Toward the end of the war, motion picture systems were installed in the fuselages of some aircraft. These "blister cameras" were installed in selected F-100, F-105, and F-4 aircraft.[21] Blister cameras did not generate the same aerodynamic penalties as external pods but were normally restricted to a fixed rearward angle.[22] While the blister camera movie film did supply the Air Force with promotional film footage, it did not satisfy the requirement for prestrike photographic coverage and was not suitable for detailed poststrike analysis.[23]

Bombing Accuracy Studies

Prior to the Vietnam War, an overriding focus on fighting a nuclear war affected force structure and training. Tactical forces reflected this trend as most supersonic fighter-bombers were made capable of delivering nuclear weapons. Aircrew training focused almost exclusively on nuclear weapons employment and not conventional weapons delivery.[24] American forces subsequently arrived in Vietnam without the skills necessary to fight a conventional war. Pilots were not proficient in conventional bombing and many had never even fired their aircraft's gun. This lack of preparedness haunted the Air Force during the early days of the war, particularly the disappointing results of initial North Vietnam conventional bombing missions.[25]

After the embarrassing results of Operation Flaming Dart and the initial Rolling Thunder missions, Seventh Air Force, reacting to White House pressure, initiated a detailed bombing evaluation and improvement program.

> When the Rolling Thunder campaign began, the average circular error probable (the radius of a circle centered on the target within which half of the bombs will fall) was nearly 750 feet. It took several years to increase bombing accuracy and achieve a circular error probable of 365 feet. Although 750 feet may have been insignificant inaccuracy when dropping nuclear weapons, it becomes very significant when dropping conventional explosives on small targets such as individual buildings or bridges.[26]

Determining bombing accuracy of missions flown in North Vietnam turned out to be difficult to accomplish. As a result, Seventh Air Force established a program in which pilots marked their planned aim point on a vertical photograph and then subsequently transcribed their KA-18/71 strike camera film results to determine bombing accuracy.[27]

Bombing studies were highly dependent on strike camera-equipped aircraft.[28] The F-105 study had to be postponed until a sufficient number of aircraft were outfitted with strike cameras. Bombing accuracy studies using other reconnaissance sources were difficult to coordinate. Any appreciable length of time delay between the attack and subsequent reconnaissance rendered analysis difficult. Follow-on attacks on the same target could preclude precise crater correlation due to the confusion introduced by additional

ordnance impacts.[29] Bomb crater correlation became a critical part of the BDA process and accurate bomb correlation was required for detailed follow-on weapons-effects assessments. Precise bomb crater locations were distributed to all fighter units. Each unit maintained a detailed photographic library to facilitate BDA determination and bombing accuracy studies.[30]

Another reason units maintained their own strike film library was the difficulty they had in acquiring sufficient reconnaissance imagery. Secondary imagery dissemination between units in-theater was considered a severe combat deficiency. This shortfall was deemed a major problem requiring "priority" postwar corrective action.[31]

Strike Cameras—A Managed Resource

Strike cameras were a unit-managed resource and would be assigned special positions in each flight. Typically, numbers two and four in a formation would be designated to fly strike camera-equipped aircraft.[32] Specific efforts were made to have KA-71–equipped aircraft in an optimum position, considering target area defenses and types of munitions delivered, to acquire the best film results.[33] Once Wild Weasel aircraft were equipped with the KA-71 strike camera system, conditions permitting, they would attempt to make a camera pass to record BDA results after the last attack aircraft had dropped its bombs.[34]

After dedicated reconnaissance photography became available, it was used to supplement onboard strike camera film.[35] In order to have an accurate assessment of bomb damage and weapon effects, photographic information from multiple sources was often needed to piece together complete mission results. But it was considered "impossible" to determine the full weapon effects of air-delivered munitions without the use of onboard fighter aircraft photographic documentation.[36] Strike camera results were vital for both the operational and intelligence communities for bombing accuracy, crater correlation, and BDA. Additionally, the meticulous and precise collection of data in Southeast Asia provided assorted agencies with the detail and correlation necessary for follow-on weapons effectiveness and target vulnerability studies.[37]

Russian Freighter Incident

President Lyndon Johnson's worst fear was having a pilot drop a bomb on a Soviet freighter in Haiphong Harbor, the ship catch fire and sink, and the pilot be a Democrat from Johnson, Texas.[38] On 2 June 1967, two pilots fired on the Soviet ship *Turkestan,* in Haiphong Harbor. The resulting Soviet protest created an international incident.

To the aircrew in Vietnam, the arrival of significant quantities of new strike camera kits seemed to coincide with the increasing scrutiny they were receiving after the *Turkestan* incident. Aircrews became openly suspicious of supervisory use of the strike camera film for monitoring compliance of the rules of engagement (ROE).[39]

Strike Film in the Intelligence Process

Units considered processing KA-71 film a priority to provide attack results, ascertain BDA, and acquire intelligence information.[40] Delivery of strike film to the processing facility was specified not to exceed 10 minutes from engine shutdown. Processing personnel were directly assigned to the fighter unit to support film development.[41] For example, the KA-60 support system included ground processing equipment, analysis displays, logistic support, and dedicated personnel.[42] Each unit was manned with photo interpreters, targeteers, and intelligence personnel trained to acquire and report intelligence information from strike camera film.

Typically, units would have their KA-71/KB-18 strike cameras downloaded, processed, and delivered to wing intelligence for review within 30 minutes.[43] The squadron intelligence section had the overall responsibility for strike camera film analysis.[44] The intelligence officer was

> responsible for processing strike gun camera and radar scope photography, performing maintenance of photographic and photo processing equipment, readout of the KA-71 and radar scope film, and the normal intelligence support to include aircrew briefing/debriefing, preparation of target materials, [Escape and Evasion] E&E briefings, and enemy [air order of battle] AOB and [ground order of battle] GOB plotting.[45]

After initial film review and interpretation, the film was brought to squadron operations for further analysis.[46] The intelligence officer and a photo interpreter assessed the film in conjunction with the aircrew, and an initial photographic interpretation report (IPIR) was completed and submitted in accordance with Tactical Air Command Manual (TACM) 200-1.[47] Mission results correlated by strike camera film were considered "confirmed."[48] In addition to BDA, strike camera film became a key part of the targeting cycle to determine future strike and retasking requirements.[49] After the time-sensitive film reviews were accomplished, the negatives were washed, dried, labeled, and then stored in the squadron intelligence section.[50] Strike camera film was considered a valuable source of imagery and kept on file for subsequent missions.[51]

Strike Cameras Integral

By 1970 the need to equip all fighters with a strike camera system was considered a "long-standing requirement" of tactical air forces to obtain an "immediate record" of attack results.[52] Even the lightweight F-5 aircraft was equipped with a KA-60 panoramic strike camera system to record ordnance deliveries.[53] Strike cameras were considered the "primary means of acquiring over-the-target film documentation."[54] Strike film supported a number of requirements to include operational intelligence assessments, aircrew training, target area information, military leadership review, and congressional briefings.[55]

At the close of the Vietnam War, efforts were ongoing to improve existing strike camera systems. Shortly after the war, the Air Force upgraded strike

camera-equipped F-105s, F-4s, and A-7s with improved filter assemblies to facilitate better strike assessment.[56]

Future strike cameras were expected to correct Vietnam-era deficiencies, such as being unable to accommodate filming of the new cluster bomb unit (CBU) and high-drag munitions. These munitions had longer bomb trail distances and periodically impacted outside of the KA-70 strike camera's field of view.[57] Also, when delivering ordnance in a highly defended area, photographic results were degraded by jinking or threat-avoidance maneuvers. Follow-on cameras were expected to have a gyro stabilization system to provide high-quality intelligence information for tactical decisions.[58]

Even with recognized deficiencies, all tactical aircraft were still expected to be equipped with either an improved KA-71A or KB-18 strike camera for combat assessment and documentation.[59] Aircraft deploying to Vietnam had been given priority for installation of strike cameras and all F-100s, F-105s, and F-4s not previously modified were planned to be retrofitted.[60] However, strike camera upgrades were not accomplished during the post-Vietnam period of military cutbacks.

1970s Degradation of the Bomb Damage Assessment Process

Toward the end of the Vietnam War, it was the common belief that any future conflict would require onboard fighter photographic documentation. In addition to BDA acquisition, onboard film documentation was deemed necessary to provide intelligence information and to properly portray air power's contribution to any campaign.[61] Fighter squadrons were expected to deploy with a self-contained capability to support any level of contingency with strike camera film processing and analysis.[62]

During the 1970s, air-to-air training was greatly expanded and units began to use homemade patch cords and miniature Sony cassette recorders to tape air-to-air commentary. In 1970, an audio-video recording system (AVRS) was tested for fighter aircraft. This test was designed to determine the feasibility of modifying fighter aircraft and to establish the operational training potential of onboard video recordings.[63] This system filmed the pilot's gun-sight view to record air combat maneuvering and shot parameters, dart gunnery, and conventional bombing missions.[64] Early video systems showed definite promise, but needed video tracking improvements prior to fielding. Due to planned early fielding of video recording devices and post-Vietnam cost-reduction measures, tactical units did not install audio cassette recorders in their aircraft. Unfortunately, video recording systems were not promptly fielded, and fighter squadrons had to make do with makeshift patch cord audio recording systems throughout the 1970s. At the end of the 1970s, aircraft like the F-16 were fielded with an internal video recording system capable of filming the heads up

display (HUD). The F-16 video system was fielded specifically for training purposes but was also capable of fulfilling air-to-air gun camera documentation requirements. The 20-minute (later 30-minute) recording time was considered sufficient for most "envisioned" operational training missions.[65] The immediate postflight playback and the reusable tape features were considered superior to the delays and limitations associated with photographic gun camera film.[66] As units were equipped with onboard video recording systems, the combat film documentation process began to disappear. Units rarely used the few remaining strike camera systems, and intelligence photo interpreter support personnel were gradually removed from fighter squadrons.

1980s Strike Cameras Disappear

Air and now space reconnaissance and surveillance systems have become the backbone of intelligence operations in both peace and war.

—AFM 1-1, vol. 2

Commenting about the Gulf War BDA shortcomings, General Horner criticized the defense community for becoming overly entranced with certain forms of intelligence collection.[67] Throughout the last decade, tactical onboard recording devices have not received the attention other systems have for intelligence acquisition. Too much reliance has been placed solely on external imagery to support combat operations.[68]

During the 1980s, tactical aircraft were equipped with training onboard video recording systems. Most of these were black and white three-quarter-inch formats, with only a 30-minute recording time. Meanwhile, aircraft from the Vietnam era equipped with strike cameras were retired from the Air Force inventory. The only fighter aircraft in the active inventory still equipped with a strike camera is the F-111. The F-111 is equipped with a KB-18A strike camera (appendix D). Its function, as stated in its flight manual, is to "provide bomb damage assessment and low level day photographic reconnaissance."[69] However, the camera is not gyro stabilized, so the pilot must still keep the target positioned directly behind the aircraft on egress to facilitate photographic coverage of munitions impacts.[70]

During the 1986 Libya raid, some of the limitations of solely relying on external reconnaissance assets were highlighted. F-111 onboard video recorders, which filmed the AN/AVQ-26 forward-looking infrared (FLIR) Pave Tack system, proved to be a key source of combat information.[71] The videotapes provided specific bomb correlation and quelled Libyan propaganda.

> [The videotape] imagery countered enemy disinformation in the early 1980s when a single videotape showed F-111 precision bombing of military targets in Libya, crushing Libyan leader Moammar Gadhafi's assertion that US aircraft targeted innocent civilians.[72]

Secretary of Defense Caspar W. Weinberger acknowledged the value of onboard video as he wrote:

> Perhaps the most dramatic evidence of our success came from the actual in-flight films provided us by the Air Force lead pilot for the Tripoli Military Airfield target. . . . As the pilot found the target, a large apron upon which sat the large Soviet-built military transports, the camera zoomed in. You could clearly see the laser-guided bombs release and home in on the target, and then the entire apron disappeared in a huge cloud of smoke as the bombs obliterated the Soviet transports. I took that tape to the White House and showed it [to] the President, and later released it to the press.[73]

While Operation Eldorado Canyon highlighted BDA shortcomings, the combat assessment requirements and system limitations were overlooked, probably because it was only a single mission. While onboard video was seen as clearly useful in the combat assessment process, the need for accurate postmission correlation of each individual munition was not recognized as a potential shortfall for larger-scale operations.[74]

1990s Desert Storm Reliance on Cockpit Video

Desert Storm highlighted the weaknesses of relying exclusively on external reconnaissance sources.[75] Routine use of overhead photography for arms control or strategic economic studies is not as time sensitive as combat operations.[76] While there are those "who favor using space systems for virtually all reconnaissance requirements," Desert Storm clearly indicated that other sources of BDA information are also needed.[77] The pace of modern warfare requires continuous intelligence updates to efficiently utilize high-tech combat forces.[78] In Desert Storm,

> poor weather early in the campaign severely hampered verification of target destruction and created difficulties in providing the verifications to target planning staffs in a near real-time manner. This is further complicated by the way precision guided munitions attack their targets, often leaving minimal exterior damage while destroying the interior of the target. These factors tend to render BDA inflexible and time-consuming. Some of these problems were corrected when cockpit videos became available.[79]

The US relied on a combination of reconnaissance aircraft, satellites, and unmanned aerial vehicles (UAV). However, the resulting BDA for campaign and restrike decisions was clearly inadequate.[80] Onboard training video systems provided much of the time-sensitive BDA information needed by planners for campaigning. For example, F-15E video was extensively used to assess tank kills and the F-111 Pave Tack system allowed aircrews to determine the effectiveness of laser guided bombs against individual aircraft shelters.[81] Because the intelligence system was not fully prepared to use the information provided by onboard recording devices, the entire process was inefficient. Additionally, onboard video was not utilized to its full potential.[82]

Degradation of the Armament Recording Program

Training should prepare aerospace forces for combat. Training has little value unless it is focused on the ultimate purpose of aerospace forces—to fight and win.

—AFM 1-1, vol. 1

Tactical Air Command (TAC) (now Air Combat Command) recently elected not to continue its supplement to the armament recording program (ARP). They concluded that TAC had "no training use for a combat camera system in peacetime."[83] The deleted TAC Supplement to AFR 95-13 was viewed only as a training regulation, not combat documentation guidance. During the 1980s, units viewed the ARP as basically a silver-recovery process and the base photo lab (now combat camera) was needed only when the F-5 Aggressors were deployed.

Over the years, the primary focus of the armament recording program has shifted away from direct squadron support to providing general wing-level services. Additionally, combat camera now emphasizes support for formal "training syllabi," not combat assessment.[84] However, the principle purpose of the ARP was to provide combat documentation guidance, as stated in the following 1974 version of AFR 95-13.

> The primary purpose of the ARP is to provide imagery for evaluation of weapon system effectiveness; that is, by confirming whether it reached the target, and recording the result of impact, the effectiveness of a weapon system can be evaluated. The secondary purposes of ARP materials include crew training, intelligence assessment, and documentation. Secondary applications must bear appropriate priority in determining acquisition requirements, and material handling methods. However, the secondary uses must not compromise the effective use of armament recording materials for the primary operational purpose (that is, weapon systems effectiveness evaluation). In most cases, materials which fulfill their primary purpose will also fulfill all secondary purposes.[85]

The requirement for color film documentation in combat was also recognized in the old edition of AFR 95-13 as follows:

> All record ARP motion picture photography (including gun camera) will be accomplished in color, provided that the technical characteristic of the sensor is capable of producing a color image. If color photographic processing support facilities are not available, black-and-white photography may be accomplished as a temporary expedient; however, action will be taken by the responsible command to expedite establishment of a color processing support capability.[86]

In Vietnam, overall supervision of combat camera systems, "film processing, film handling, tactics evaluation, aircrew proficiency, and informational use was the responsibility of the operational squadron commander."[87] Combat documentation personnel were assigned directly to fighter squadrons, and units had strong armament recording programs. Unfortunately, since then the guiding regulation for combat documentation (AFR 95-13) has deteriorated to an ineffective level. Combat camera's squadron-level responsibilities for combat documentation have become ill defined. Consequentially, due to the lack of ARP guidance, fighter units were not prepared for combat documentation.

> Photographic documentation of tactical air operations, as opposed to tactical photo reconnaissance, is an oft overlooked but vital requirement of the tactical mission. In peacetime, the production of training and orientation film is a continuing requirement. . . . However, combat is the ultimate test. It is the test that determines to what degree we have met expected performance levels. To what degree are our weapons systems and weapons employment tactics and techniques effective, and most important of all, to what degree have we destroyed the target. Here is where aerial combat photography and photographic documentation pay their highest dividends.[88]

Since Vietnam, intelligence and photographic support for unit-level BDA analysis has been removed from fighter squadrons and consolidated at the wing level. Over time the total number of intelligence interpreters and targeteers were reduced as a peacetime efficiency.

Desert Storm combat camera products were not optimized for combat assessment. They lacked sufficient detail and standardization to be effectively used in follow-on munitions and weapon system studies. Completeness of the captions varied as the more detailed ones only "included mission number, date, unit, aircraft type, and target number for each tape segment."[89] Combat camera products were more suited for unit keepsakes and media releases than for combat assessment. Previously, they preserved combat imagery and archived combat film for follow-on analysis and historical purposes.[90] However, during Desert Storm, combat imagery was not properly collected, cataloged, preserved, or archived. The peacetime disappearance of an armament recording program directly contributed to BDA problems experienced during and after Desert Storm. Both combat camera and operational fighter units had forgotten their combat assessment documentation responsibilities for BDA and follow-on weapons analysis. This lapse can be directly attributed to the lack of regulation guidance and a peacetime focus on cockpit video as a training tool instead of a combat documentation source. With the advent of dedicated reconnaissance systems, the need for attack platforms to accurately correlate their munitions impacts with other sources of reconnaissance was also forgotten. Many of the Desert Storm BDA shortfalls can be directly attributed to the degradation of the armament recording program.

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Chapter 3

A Role for Onboard Video

The following presentation was made at the day-two press briefing during Operation Desert Storm:

> This is my counterpart's headquarters in Baghdad. This is the headquarters of the air force. Keep your eye on all sides of the building. The airplane overflies the building and drops the bomb down through the center of the building.[1]

This graphic presentation, using an attack aircraft's onboard video, legitimized General Horner's claims of precision US bombing to a skeptical world press. Fighter aircraft onboard video was used for a variety of purposes throughout and after the war. However, very little guidance exists in either operations, intelligence, or combat camera publications on how to use onboard video in combat operations.

While various intelligence agencies as a whole performed well during the war, the "institutionalized" intelligence BDA process did not sufficiently support the unit-level war fighter.[2] Desert Storm caught the intelligence community unprepared to handle the quantity and tempo of BDA assessments. Users of tactical intelligence required "more, better, and faster" results to take advantage of the lethality of newer weapons.[3] Bomb damage assessment efforts were further complicated by the introduction of large numbers of highly accurate precision guided bombs, unique coalition munitions, and imagery analysts conducting bomb damage assessments without knowing either the type of munition dropped, fuze, or delay element.

Doctrinally, the intelligence community began to accept only externally derived imagery as a true source of BDA. Gun camera footage was not considered valid BDA; it was thought to indicate only whether a bomb was released successfully.[4] This perspective was clearly expressed in the following comments to the press during Desert Storm by Assistant Secretary of Defense for Public Affairs Pete Williams:

> First of all, let's draw a distinction between bomb damage assessment, which is basically what you're asking for, and so-called gun camera footage. They are two mutually exclusive things. Gun camera footage shows the success or failure of whether a specific bomb was dropped on a specific target. That's about all it tells you. It tells you whether the ordnance exploded properly, it gives you some very rough indication of what may have happened, but the plane is gone very quickly.[5]

These types of misconceptions resulted in onboard video systems' being underrated and underutilized for BDA and virtually overlooked for intelligence acquisition during the Persian Gulf War.

Desert Storm shortcomings highlighted the inadequacies of relying solely on external assets to supply information required by combat planners and decision makers. To the war fighter, operational suitability of reconnaissance products depended on their timeliness for tactical decision making.[6] As General Horner said after the war, timeliness of tactical intelligence has become a "crucial factor in battle."[7] Intelligence personnel overlooked the fact that frequently the most appropriate sensor to determine mission results, particularly for tactical decision making, was aboard the attack aircraft.

Tactical fighter units and CENTAF planners began to use onboard fighter aircraft video to orchestrate the air campaign. Decision makers needed to act immediately on attack success or failure and frequently could not wait for an external analysis to provide an independent strike confirmation. As a result, in order to plan the next wave of sorties, Desert Storm planners frequently cut intelligence personnel out of the process.[8]

After the war, tactical commanders stressed the need for a better BDA process to be instituted prior to the next conflict. Military commanders were not satisfied with Desert Storm reliance on national assets. They strongly expressed a need for near-real-time information upon which to base tactical decisions.[9] Additionally, they felt nationally controlled systems could not be relied upon to provide the degree of support new weapon systems and smart munitions required to be employed effectively.[10] War-fighting commanders desire a greater degree of self-sufficiency. They would prefer to have BDA assets under their control for making tactical decisions and targeting.

BDA difficulties during the war subsequently resulted in combat assessment problems after the war. Detailed analysis of many of the Desert Storm munitions and weapon systems cannot be accomplished, because attacks and results could not be correlated. In some cases the lack of detailed records make even a cursory analysis impossible.[11] Simply, a considerable amount of the data necessary to conduct munitions-effects assessments was not collected or properly preserved.

With few exceptions, fighter units were just not prepared to collect and preserve combat assessment data information because it did not receive proper peacetime emphasis. Many of the postwar assessment problems could have been alleviated if all attack platforms had been equipped to record the effects of their munitions and these recordings had been properly titled and preserved.[12]

Desert Storm has spurred several studies to reevaluate bomb damage assessment processes. For example, the Air Staff has several initiatives under way to improve bomb damage assessment concepts and methodologies.[13] However, most of these initiatives focus on improving either the overall joint or high-end BDA architecture and overlook the key role onboard video played in the BDA process.

This chapter will explore the role attack aircraft onboard video should play in the intelligence and BDA processes, by categorizing its uses in Desert Storm and examining the associated doctrinal issues.

Demonstrated Onboard Video Uses

It has been well demonstrated that onboard video can be used for a number of purposes. The first is its ability to determine the DMPI.

Desired Mean Point of Impact Determination

Onboard video was utilized to determine a munition's precise impact point. This is very similar to the Vietnam-era strike camera film's being used to identify and correlate each aircraft's bomb craters. The quality of the data provided by onboard video recordings varied considerably, depending on the aircraft's video system, ordnance-delivery altitude, tactics, unit guidance, and the sensor used to acquire the information. For example, day high-altitude deliveries recorded few of their own impact points, while night infrared attacks were routinely able to film their entire bomb delivery. Some aircraft even recorded the impact points of other flight members' bombs. In one case an F-111F crew filmed the impact of all five preceding aircraft's bombs in addition to their own.[14] F-15Es would periodically film the target area outbound after munition impact, explicitly showing target damage after the smoke and dust had cleared. Some of the new electro-optical munitions also provide video attack documentation. For example, the GBU-15 provided a panoramic picture of the target area and weapon's impact trajectory, giving an accurate determination of its impact point.[15]

Pete Williams's following commentary to the press reflects onboard video's ability to accurately determine DMPIs:

> On the next run, you can use the TV as battle damage assessment, because you can see what the first weapon did. This is a two-weapon salvo. The next weapon that comes in will not only be right on target, but it will fly through the hole that was made by the first weapon.[16]

Onboard video was particularly useful in determining impact locations of munitions dropped under conditions of bad weather, smoke, haze, or on a secondary target.[17] Reconnaissance platforms normally focus their sensors on a fragged DMPI and not necessarily on a secondary target. Attack aircraft onboard video was heavily used in determining munitions' impact locations throughout the war.

Precision Guided Munition Analysis

Desert Storm showcased warfare with large quantities of precision guided munitions. The vast increase of targets struck accurately overwhelmed the BDA system. PGM munitions virtually required an assessment for each bomb dropped. The penetrating nature of hardcase munitions further complicated the BDA process because these munitions produced little external evidence but could generate significant internal blast damage.[18] Impacts on the sides of structures also complicate assessments because they are difficult to detect.

With the accuracy of PGMs, coalition forces did not need to destroy all the buildings in a target complex to render a facility inoperative.[19] This further complicated imagery analysis and slowed the BDA process. Consequentially, there were instances of targets' being unnecessarily attacked a second time because external reconnaissance assets were unable to verify target destruction.[20]

Onboard video was integral in assessing the results of PGMs. It frequently would capture secondary effects indicating severe internal damage, not easily detected by still imagery analysis. Future conflicts will virtually mandate the use of precision guided munitions to achieve target destruction and avoid collateral damage.[21] Onboard video proved to be essential in assessing PGM deliveries during Desert Storm and can be expected to be vital in a future conflict.

When Weather Restricted Other Systems

Desert Storm intelligence collection assets were finite and frequently impacted by the weather.[22] Weather has been a factor in every war. For example, during the Korean War, bad weather prevented coverage of 35 percent of the February 1953 assigned reconnaissance targets.[23] Poor weather during various phases of Desert Storm "severely hampered verification of target destruction."[24] Cloudy weather made BDA assessments erratic and affected their accuracy.[25] The lack of concrete results to display to the public was maddening to military commanders, DOD officials, and political leaders.[26] General Kelly told the press on several occasions that coalition forces were having problems determining BDA due to the weather.[27] Former Secretary of the Air Force Donald B. Rice described the Gulf War weather situation as follows:

> The weather over Iraq during Desert Storm was the worst in fourteen years, twice as bad as climatological history of the region would have suggested. The conditions, in fact, approximated a rainy European summer, not the kind of blue-skies conditions one normally associates with desert warfare. Cloud cover exceeded 25 percent at 10,000 feet over central Iraq on 31 days of the 43 day war; it exceeded 50 percent on 21 of those days, and 75 percent on 9 days. Accompanying this cover were occasionally violent winds and heavy downpours that played havoc with targeting and bomb damage assessment.[28]

If the weather is adequate for an attack aircraft to deliver its munitions, the same sensor used to deliver the ordnance can normally film the attack. Onboard sensor video recordings provided mission results during periods of poor weather when other assets were unable to provide BDA. Timely BDA information is essential in all types of weather to successfully execute an air campaign.[29] Onboard video was available to decision makers when other sources of BDA were not.

BDA When Not Available from Other Systems

As with the weather, onboard video can provide a source of information when other assets are not available. This includes when reconnaissance assets are diverted to support other tasking, restricted by the threat, malpositioned

to acquire BDA, or simply shot down. Additionally, target area defenses can restrict the access of reconnaissance aircraft or require larger support packages. In future conflicts, our reconnaissance operations may be more restricted by the threat similar to the following US Third Army Desert Storm experience:

> In January, we had to rely largely on national imagery for targeting, because early on in the air campaign, Iraqi missile air defense[s] still posed a threat to theater imagery aircraft.[30]

When not supported by reconnaissance assets, units relied heavily on their own organic onboard recordings to provide combat information for decision making. Frequently, this was the only information available before the next wave of strikers had to be launched.[31]

Mobile Targets/Fast-Moving Forces/ Nonlinear Battlefield

The dynamic battlefield of fast-moving conventional forces exacerbated the need for real-time intelligence.[32] External assets were unable to satisfy the requirement for mobile target BDA. General Horner said during a Senate Armed Services Committee hearing, "We had the most difficulty in telling how we were doing with regard to destroying his [Saddam's] tanks and armor."[33] Even the best imagery analyst with clear photography often had a hard time telling which tanks were sufficiently broken and which were not.[34] Consequentially, CENTAF planners and intelligence personnel had to rely upon onboard attack video as their main source of information for BDA attrition counts.[35] The following commentary by Brig Gen Robert A. Neal to the press is an example of the detail onboard recordings can provide.

> I'll show you one last film clip which shows the attack of Kuwaiti equipment in the field. We'll begin with F-111's using laser-guided bombs against tanks. You'll see large chunks of armor come out there as the tank is blown apart.[36]

General Horner testified to Congress that our attack aircraft onboard video systems provided a good capability to assess mobile target BDA. From onboard video assessments, "we had a good idea how many tanks we were killing in a given area each night."[37] Secretary Rice further described the value of onboard video as he said, "Strike video, showing the results of a Maverick or GBU-12 hitting a tank or other target, generally proved the most useful means for planners to assess the destruction."[38]

Imagery intelligence has been the traditional primary source of BDA information and will likely remain a staple in the future.[39] However, an increase in newer weapons such as the Army tactical missile system (ATACMS), multiple launch rocket system (MLRS), and a nonlinear battlefield will further tax reconnaissance assets and imagery analysts.[40] Additionally, the movement of high-speed forces has created the requirement to know accurately the locations of greater numbers of friendly and opposing forces.[41] Analysis based on the forward line of troops or direction of tank movement may not be as valid

in the future.[42] Hence, with fast-moving, mobile, or relocatable forces, onboard video may be the only viable method to determine BDA and overall attrition levels. However, onboard video needs to be properly weighted to compute attack results more accurately, a subject that will be discussed later in this chapter.

Intelligence Acquisition

Col John R. Dyas, writing on the subject of technical reconnaissance, said, "Information is the foundation of all plans and action."[43] AFM 1-1 advocates that in addition to benefiting from intelligence, aerospace forces contribute to the creation of intelligence through their abilities to conduct reconnaissance and surveillance communicate information to analysts/decision makers, and assess strike damage.[44] The intelligence-gathering potential for onboard attack aircraft video is only in its infancy stages. The same sensors used to deliver munitions could also have provided a significant amount of additional intelligence information, a capability essentially overlooked during the Gulf War.

Onboard attack aircraft video can provide information of intelligence value about targets and facilities not necessarily under attack. For example, F-15Es were used for "river recce" to locate standing or pontoon bridge spans.[45] A-10 aircraft used imaging infrared Maverick missiles to identify and then to individually select Iraqi tanks to attack.[46] F-111 crews used their forward-looking infrared (FLIR) equipment to locate buried armor.[47]

> Infrared detectors . . . were used to determine which bunkers had tanks inside. Surveillance was conducted at dusk when the desert sand had cooled down, but the metal in the tank still held the heat.[48]

Iraqi defensive positions also showed up well on the F-15E attack radar.[49]

Modern attack aircraft are equipped with sensors ranging from those providing activity detection to sensors capable of detailed target analysis.[50] Gen Merrill A. McPeak acknowledged the intelligence value of these modern sensors when he said, "It's intelligence, but it's intelligence that is processed by the aircrew and acted upon immediately."[51] Since attack aircraft are now equipped with onboard recording systems, they are capable of bringing back that sensor-acquired information for further exploitation. However, the intelligence community was predisposed to use only external imagery for BDA due to its "objectivity." Unfortunately, a great deal of information available through onboard recordings went unused or unexploited during Desert Storm due to this predisposition.[52] According to Air Force Pamphlet (AFP) 200-17, *An Introduction to Air Force Targeting*, "a BDA analyst must make use of all source inputs, to obtain the best possible understanding of damage suffered by the enemy."[53]

The role of tactical intelligence is to provide commanders with accurate information as the basis for decision making and not solely for up-channel reporting.[54] Unfortunately, over the years since Vietnam we have removed imagery analysts and targeteers from our fighter squadrons.[55] Squadron

intelligence personnel now focus on completing MISREPs vice analysis. Additionally, the intelligence effort has become overly centralized. For example,

> air tasking and targeting was centralized at the JFACC [joint force air component commander] level, with intelligence requirements originating at the theater level and results pushed downward, in contrast to the decentralized nature of ground-combat intelligence.[56]

In general, onboard video was a vastly underutilized source of intelligence during Desert Storm.[57] The intelligence system was not prepared or structured to receive significant amounts of aircrew-acquired intelligence. We need to incorporate user-generated onboard video-derived information to a much greater degree in the BDA and intelligence processes.

Unit-Level Source of Imagery (Video Library)

General Schwarzkopf noted that a lack of tactical reconnaissance products was one of the more significant shortfalls of the war.[58] Units started to rely on their own video resources to fill this void. One fighter unit established an onboard video library of previous missions to facilitate target study. This library was used extensively as an imagery source for premission study.

During Desert Storm, reconnaissance assets were able to film more targets and loiter longer near target areas due to our air supremacy.[59] Even with this permissive environment, we were not able to satisfy tactical users. We cannot expect to have such rapid and total control of an enemy's airspace in future conflicts, particularly with the rate of today's technology proliferation. Even though efforts are under way to improve the shortage of target imagery, the utility of an onboard video imagery library has considerable merit. However, currently we do not provide units either the guidance or the resources to establish combat video libraries.

Mission Report Preparation

During Desert Storm, aircrew and intelligence personnel typically prepared MISREPs after reviewing attack aircraft onboard videotapes. The fact that MISREP data was "video assessed" was not specifically annotated. The method of preparation and degree of detail on MISREPs varied widely between fighter units. Members of one unit had to prove, by showing their videotape to their commander, that they struck the target or were not permitted to report a "hit."[60] In the F-15E unit it was tacitly assumed that CENTAF knew their MISREPs were prepared directly from an onboard video assessment.[61] Others gave equal weighting to aircrew visual sightings and video-assessed information. In one A-10 unit, the commander required specific secondary effects before his pilots could report damage to an armored vehicle or tank.[62] Additionally, each level of command added its own additional "ad hoc" qualifiers to a unit's assessment criteria.

MISREPs were routinely based only on a preliminary review of videotapes.[63] Follow-on unit-level video assessments were rarely accomplished. Some videotape was forwarded to CENTAF, some saved by individuals, and the remainder was used again (taped over on the next mission) because of a shortage of blank tapes. Other than in the F-111 and F-117 units, there was no concerted effort to preserve all the combat videotape.[64]

While the methodology and the weighting of onboard video varied, it was clearly the key source of MISREP data. However, units lacked detailed guidance on how to properly assess and report onboard video acquired information. One unit even changed its MISREP format during the war (appendices E and F).[65] MISREP procedures need refinement and standardization, particularly with respect to onboard video assessed inputs.

Media Consumption

Rear Adm Riley D. Mixson, commander of Carrier Group Two in the Red Sea, said during the Gulf War, "One large bomb on target, and recorded for proof of hit and public relations, is better than numerous near-misses."[66] Early in the war, the media focused the public's attention on Desert Storm BDA problems. A combination of operational security concerns and inherent limitations of reconnaissance systems resulted in sparse information being initially available to the press.

In his first press conference, General Horner played a couple of onboard video recordings of attack missions for the press, clearly supporting US claims of precision bombing and coalition success.[67] Political and military leaders at all levels quickly resorted to attack aircraft onboard video recordings to demonstrate combat success to the media. General Schwarzkopf also used cockpit video to counter Saddam's claims of random collateral bomb damage.[68] The following graphic narration of an attack aircraft's video is from one of General Neal's press conferences:

> Here's another attack against tanks. This is a spectacular one because of the ammunition and fuel and so forth inside the tank. . . . Here's one burning as the A-10, in this case, works against this tank with a Maverick missile. The tanks tried to get off the road. You can see them leaving the road now and driving out into the desert. In fact, some of the tankers tried to run away, you see the people running away. . . . This is a moving tank, moving it into the desert off the road. We continued to attack him. We got a pretty good sized secondary on that one.[69]

Even after the war, attack aircraft onboard video was used to showcase coalition success. General McPeak narrated one of these video presentations as follows:

> I want to show some more film here about attacks against the Iraqi Air Force, beginning with aircraft in the open. This is a Soviet bomber design, called the Badger, sitting in a revetment. We are lasing with a laser-guided bomb. Next is a Soviet fighter called the Fitter, again, in the open—we're lasing it. Now we go against aircraft shelters. . . . Here we have debris coming out both ends of that particular shelter. Here's another attack with a large secondary [explosion] coming out the top.[70]

Relating the enormous success of the air campaign in Desert Storm to a skeptical press would have been much more difficult without onboard video. Presenting weapons attacks with pinpoint accuracy to the world press helped to sustain vital international support for the war and established coalition credibility.

In the January 1993 attacks in Iraq, onboard video was again used to demonstrate mission success to the media. In addition to showing attack success, the video recordings were also used to show clouds obscuring one of the target areas, justifying the need for the next day's follow-on attacks.[71] Onboard video has become an integral part of the public relations process but lacks written guidance and procedures.

Archiving

> *Combat assessment is the examination of struck targets to determine the effectiveness of the munitions damage mechanisms, to draw conclusions as to the degree of success or failure of the attack, and to make recommendations on the need for restrikes, changes in munitions, fuzing, tactics, or strategies. It must be done jointly by the targeting, threat analysis, and operations personnel.*
>
> —AFP 200-17

"The BDA process does not end with the cessation of hostilities."[72] The weapon-effectiveness phase of BDA assessment yields significant information on weapon performance, signatures, and methods to enhance targeting.[73] However, post–Desert Storm combat assessment suffered due to lack of BDA quantity, detail, and correlation.[74] "Desert Storm BDA was . . . not adequate for weapon systems evaluation because there is not enough BDA to evaluate each tasked mission, and the quality of the assessments is lacking."[75] The air-to-air weapon-effects team did not even arrive until almost a month after Desert Storm had begun, so "most perishable data was lost."[76]

In general, Desert Storm units did a poor job of preserving mission details, particularly delivery parameters and fuze settings.[77] However, some units did a much better job of chronicling their war effort than others. For example, the F-117 unit purchased a commercial software data base to record a detailed account of the targets attacked.[78] They documented fuze settings, aim points, delivery parameters, and cockpit video results.[79]

While we did collect some of the Gulf War's mission results through the preservation of onboard video recordings, it was not done well. In fact, Desert Storm weapon-effects analysts found the hardest information "to obtain were correlated intelligence reports and cockpit video recordings."[80]

Operations personnel are busy fighting a war and cannot be expected to concentrate on collecting data for follow-on analysis, unless the process is part of their war-fighting procedures. Preserving mission video recordings and more detailed postmission debriefs can satisfy many of the combat assessment documentation requirements without mission degradation. However, these procedures need to developed, documented, instituted, and practiced if they are to be effective in combat.[81]

Implementation Issues

Desert Storm clearly demonstrated the need for a joint bomb damage assessment process.[82] BDA is a complex process requiring standardized procedures and interoperable systems to accommodate the wide range of requirements.[83] However, very little documentation exists on the role onboard video should play in the BDA and intelligence processes. Peacetime procedures for BDA and intelligence collection must be established to satisfy combat requirements and postconflict analysis.[84]

Commanders have the responsibility to see that their units are trained and prepared for combat.[85] However, combat documentation guidance has lapsed since Vietnam. No single regulatory source governs the entire spectrum of combat documentation or BDA. For example, the following postwar after-action report criticism from the OSD Technical Data Directory Project is vague because the author did not know where to direct it.

> The responsible office should be cognizant of peacetime preparations for data collection and of the degree of success being achieved in data collection during exercises, crises, or hostilities. The oversight process should include a mechanism for reporting the status of collection preparation and for periodic reviews of policy and preparedness.[86]

With degradation of the armament-recording program, removal of imagery analysts from fighter squadrons, and an implied promise of complete wartime BDA support from national systems, units were unprepared for their Desert Storm BDA responsibilities. This section will examine issues that must be addressed in order to fully integrate and institutionalize attack aircraft onboard video in the BDA and intelligence processes.

Standardized Terminology

> *Current Army doctrine regarding BDA is found in the capstone field manuals, -34 series field manuals, and targeting field manuals. Current Air Force BDA doctrine is found in AFR 200-16* (USAF Targeting) *and AFM 200-16 [sic]* (Introduction to USAF Targeting). *Joint PUBs 1, 3-0, and 2-0 also address BDA doctrine. However, none of these address all of the required doctrinal topics. Each define some BDA terms, but not all definitions are consistently the same, and not all publications address the same set of terms. This lack of agreement creates a proliferation of BDA data base models that do not have correlated contents and are not interoperable. Additionally, none of the current manuals even attempt to propose a standard methodology for BDA, nor do they adequately discuss exactly who is responsible for collecting, analyzing and disseminating BDA data.*
>
> —US Army BDA White Paper

As seen in Desert Storm, BDA requires inputs from a variety of sources, to include each of the services. Consequently, we need a joint standardized terminology for all developers and users of BDA. This initiative is under way, and appendix G contains the recently released joint terminology from the battle damage assessment working group (BDAWG).

Common (Joint) Data Base

Many believe one of the keys to solving the BDA problem is a timely and accurate all-source intelligence data base.[87]

> The wide variety of assets employed to survey the battlefield underscores the problem. BDA assets at CENTCOM's disposal included USAF's E-8 J-STARS [joint surveillance target attack radar system] aircraft with its synthetic aperture radar, the high-altitude TR-1A tactical reconnaissance aircraft, and other aircraft including F-14 TARPS and RF-4C.[88]

Joint operations require a rapid and systematic exchange of combat information.[89] Ideally, BDA would be "collected from multiple sources, produced from all-source analysis, and disseminated within the operational decision cycle of the user."[90]

> All possible theater sources must be identified and exploited to supplement the coverage of standard collection resources. Unconventional sources may include remote seismic/acoustic unattended ground sensors, friendly forces, media reports, unmanned aerial vehicles (UAV), legal travellers, and refugees. BDA analysts and collection managers must remain alert to all possible collection opportunities which could assist the BDA effort.[91]

However, as seen in Desert Storm, intelligence analysis and distribution was not timely enough for tactical decision making. The Air Force needs a better method to integrate diverse intelligence sources and sensor systems.

Planners at the national, theater, and wing levels all need BDA information. National- and theater-level planners use BDA to determine the overall campaign progress. Theater planners prepare the air tasking order (ATO) and determine restrike requirements. Unit-level decision makers use BDA to determine attack effectiveness and the requirements to modify tactics, munitions, and fuzing.[92]

> On one hand, Washington has the best resources to exploit the peacetime intelligence. However, the very large volume of theater intelligence that becomes available during wartime is unavailable to them in the near term except as message traffic.[93]

Additionally, "there was no system specifically designed to provide feedback from the tactical user to the national level producer."[94]

One potential solution to this dilemma is a universally accessible common target data base storing all BDA inputs. All information on target damage would be recorded in this data base and be readily available for reference or analysis at each command level.[95]

> Whether it comes from local human sources or airborne collection assets, the data must be collected, analyzed, and disseminated to the user as near a real-time rate as possible. Knowing both the condition of targets to be struck and the bomb damage assessment on those already hit is critical to the planner who is attempting to maximize the use of available resources.[96]

Currently there is no commonly accessible data base to record, store, or monitor the progress of BDA analysis.[97] Various agencies are working on developing a joint data base architecture for BDA reporting.[98] Onboard video

should be a key source of combat information in any data base if it is accorded the proper weighting, but the intelligence community has had a long-standing dislike for the dissemination of "raw" intelligence.

> Raw intelligence is information that has not been further developed through analysis, interpretation, or correlatio . with other intelligence. Finished intelligence is information that has been analyzed, integrated, interpreted, and evaluated.[99]

Combat systems and tactical decision makers are moving more toward using raw combat information. From a war fighter's perspective, raw data should be available in the absence of more finished products. In cases where time counts, raw information is much preferable to no information.[100] Waiting for finished intelligence is not always possible with the tempo of modern combat "Timely intelligence is essential for the tactical commander to direct and cue his own collection resources and sensors to meet threats and engage an enemy."[101] Additionally,

> intelligence cannot be totally free of inaccuracy, human error, and prejudice. Subjective judgments are essential because opponents usually prevent collection of complete intelligence information.[102]

As seen in Desert Storm, "raw" intelligence provided by onboard video recordings was preferable to late or insufficient processed or produced BDA. If it is not possible to determine the accuracy of the information, disseminate the information to appropriate users with caveats if necessary.[103] Even with caveats, information acquired through onboard video recording devices will be a key contributor to an all-source data base.[104]

Revitalize the Armament Recording Program

During Vietnam, strike camera film was considered an integral part of the BDA process.[105] However, the elimination of strike cameras and perception of onboard video as only a training system contributed to the degradation of the armament recording program (ARP). The office of primary responsibility (OPR) for the ARP, combat camera (the old base photo lab), has gradually distanced itself from its Vietnam role of unit-level developing, processing, and preserving squadron combat recordings. The operations and intelligence communities are equally negligent in keeping this program viable. Since Vietnam, we have gradually shifted away from combat effectiveness to peacetime efficiency. "Although peacetime efficiencies are in constant demand, they can be self-defeating if they hinder rapid and effective transition from peace to war."[106]

Air Force Regulation (AFR) 95-13, *Armament Recording Program*, and command supplements must be revived to provide unit-level BDA direction. This regulation should specify combat video preservation requirements, war reserve materiel (WRM) tapes, documentation, and archiving procedures.[107] Additionally, there is also a need to standardize onboard recording systems to ensure interoperability and secondary imagery transmission capability. Commanders must keep a wartime perspective amongst the plethora of peacetime

procedures.[108] The armament recording program should be revived as a single-source reference for all combat documentation.

Restore Combat Camera's Squadron Role

Over the years, combat camera has distanced itself from the squadron combat documentation function, even though it did reproduce a number of videotapes during Desert Storm. Vietnam-era squadron photo support has evolved into a general base support agency and no longer emphasizes aircrew combat film documentation.[109] For example, flying units do not include combat camera in their daily training, exercises, evaluations, and TDY deployments like Red Flag or the Weapons System Evaluation Program (WSEP). Additionally, combat camera has become divorced from onboard aircraft recording system requirements and maintenance.[110] Units must rely on other base agencies for repairs and maintenance of debriefing video playback systems.

A Headquarters TAC Joint Studies Group Desert Storm Data Assessment Report found combat camera products produced during the war varied significantly in degrees of completeness. These tapes were primarily made for home unit use or media dissemination and not suitable for follow-on combat assessment.[111] To fill this void, a DOD effort to acquire and preserve Desert Storm video on a laser disk storage medium was initiated about a year after the war. Unfortunately, a significant amount of the onboard video had already perished. There should be standardized procedures for documentation and preservation of onboard video recordings. Combat camera should be providing regulation guidance for documentation, editing, indexing, and preservation of onboard combat video.[112] Additionally, most units did not have sufficient blank videotapes to preserve each mission.

> The potentially valuable exploitation of data . . . [from] some types of aircraft suffered due to the shortage of replacement tapes. This shortage and the requirement for tape reuse precluded data sharing among units and tape retention for more in-depth postflight analyses.[113]

Each aircraft's video system is unique. The systems vary in visual quality (fidelity), format, and recording time, because they were individually acquired principally for training purposes, not combat documentation. As a result, the overall video quality for both intelligence analysis and for secondary imagery transmission needs improvement. Additionally, all Desert Storm combat video recordings should have been archived to facilitate follow-on intelligence analysis, mission study, and postconflict assessments.

> At . . . the squadron level and certainly at the wing and air group level, enhanced high speed review and weapons impact freeze frame recording, BDA data forwarding and cataloging would have enhanced the tactical BDA process.[114]

Future wars can be expected to be fought by coalitions. As a result, we may be required to assess and retransmit a coalition partner's onboard recordings for BDA.[115] These video systems may be based on another recording standard and not necessarily compatible with our systems. For example, during Desert

Storm there was a requirement to handle Program Assembler Language (PAL), SECAM, and NTSC video formats.[116] Any future video selective imagery dissemination system (SIDS) architecture must be capable of handling a variety of video formats.[117] Ultimately, we need complete interoperability of national, theater, and unit-level imagery systems.[118]

Combat camera should be the focal point for standardizing onboard video systems, interoperability, and future requirements. Additionally, we should reestablish combat camera as an integral part of the flying squadron combat documentation process. There is a definite need to establish unit-level procedures for reproduction, retransmission, and preservation of combat video recordings.[119]

Specify Combat Data Collection Procedures

As discussed in chapter 1, munition effects assessments during and after the Gulf War were incomplete due to insufficient detail and lack of correlation. "Most of the major collection efforts were conducted after cessation of hostilities. As a result, much of the highly perishable data was lost."[120]

> BDA producers must plan for the retention and storage of a large volume of BDA material for postconflict analysis. A . . . policy must be developed to ensure valuable data is not lost during the conflict.[121]

Initiatives such as the Weapon Effects and Performance Data Archival (WEAPDA) data base were efforts initiated too late to effectively reconstitute all the combat information. Some estimates to reconstitute the available data ranges into the man-years just to sort and correlate. With better planning and procedures, these problems could have been avoided.[122]

The current tasking process has several combat assessment anomalies. First, planners routinely permit units to select their own munitions. While this allows unit-level flexibility, the lack of an ATO-specified munitions and fuzing complicates imagery BDA analysis. Second, the target annotation in the computer-assisted force management systems (CAFMS) data field is not consistent.[123] Third, postmission reports lacked the detail necessary for follow-on analysis.[124] Combat assessment data is useless if not collected in a scientific manner.[125]

> [Weapons and tactics data are] . . . critical to evaluating the effectiveness of tactics, weapon systems, and munitions used against the various target complexes. However, there is no standing requirement to preserve weapons and tactics data.[126]

Weapons assessment should not be an afterthought. It could be absolutely vital if an enemy develops a countermeasure to our weaponry.[127] Additionally, conclusions from weapon system analysis have a profound effect on force structure, munitions acquisition, and delivery methods.[128] As with BDA for campaigning, we need to establish better procedures for weapons assessment.

> If we wait for the next conflict to develop the plans, it will be too late. Our force management systems need changing during peacetime. To train the way we fight, these changes should be evaluated during unit exercises, combat exercises (Red/Green Flag), and unit inspections. These evaluations should include not only

> the unit's abilities to keep records, but the analysts capabilities to collect and use them.[129]

Detailed procedures for recovery and retention of combat assessment data must be established.[130] Granted, war fighting will continue to take precedence over data collection for follow-on analysis. But in most war situations, some degree of combat assessment documentation can be accomplished.[131] Equipping all attack aircraft with onboard collection and recording systems is one manner in which much of this data can be readily collected, correlated, and preserved.[132] However, combat data collection requirements and procedures must be specified in a single-source regulation to provide written guidance to war-fighting commanders.

Intelligence Acceptance and Doctrine

> *General Ridgway's Korean War complaint was "it took too long to acquire, report, analyze, and present the finished intelligence data for consideration."*
>
> —1975 Speech at Air University

Desert Storm BDA failed to meet the fundamental criterion of timeliness.[133] The intelligence community had high expectations for our national systems, but they were unable to supply sufficient timely BDA to tactical users and decision makers.[134] Combat commanders clearly expressed the need for an improved BDA process to include the development of a better procedural doctrine.[135] The DOD Title V final report to Congress stated,

> BDA will continue to be a problem for the foreseeable future. However, many difficulties encountered in Operations Desert Shield and Desert Storm can be minimized or eliminated by developing standard BDA doctrine and procedures that meet the needs of operational and intelligence communities.[136]

There is a definite lack of unit-level BDA guidance. Currently, there is no DOD-wide formalized BDA training, organizational structure, doctrine, methodology, or set of procedures.[137] There has been insufficient emphasis on combat assessment across the spectrum, from command exercises to the schoolhouse, particularly for analysts.[138] Past employment exercises had focused heavily on ATO development with only minor "simulated" input for combat assessment.[139] Combat assessment has not been realistically exercised.[140]

A wartime BDA intelligence capability for Desert Storm had to be essentially created at CENTCOM in the Joint Intelligence Center (JIC).[141] A BDA system should be in place well before a crisis to provide commanders with BDA for decision making from the outset.[142] To solve this problem, the Air Staff is participating in the Defense Intelligence Agency (DIA) BDA working group, which is creating a joint staff publication to delineate doctrine, BDA methodologies, training, and procedures.[143]

While the BDAWG is working the overall architecture for BDA, there is a definite need to define the role of onboard video in the BDA process. The disposition of the intelligence community is still toward restrike nominations solely as the result of external poststrike reconnaissance, not onboard video results.[144] Post–Desert Storm doctrinal manuals do not give onboard sensor

video recordings the weighting it deserves. For example, a draft of AFM 3-I, "Aerospace Intelligence Operations," still attributes onboard video little more credibility than the Vietnam-vintage gun camera film as it states:

> Wing/squadron intelligence analysts support the damage assessment process by preparing mission reports (MISREPs) based on gun camera film, onboard sensor data, and aircrew debriefs and forwarding these reports to the air component organizations.[145]

Onboard video is lumped in with all the other sources for making routine MISREPs. Additionally, the ability to acquire intelligence information is completely overlooked.

Air Force Manual (AFM) 2-6, *Tactical Air Operations—Reconnaissance,* written just after Vietnam, recognized the contributions of unit-level sources of combat intelligence. It references the value and legitimacy of direct and indirect collection of tactical information, "which can be used in the decision process either directly or through [an] update of the intelligence data base."[146] However, after the Vietnam War, external optical imagery was gradually considered the only reliable source of BDA. Red Flag and other training activities further ingrained the reliance on independent external scoring devices like Toss Scorers. Even the current intelligence targeting manual says optical imagery will remain the primary source for "quantifying damage against the enemy."[147]

To provide information lacking through the established intelligence BDA channels, decision makers began to rely upon onboard video. The intelligence community was unprepared to use onboard video-derived information effectively and initially treated it with little validity.[148] Gradually as the war progressed and national systems were unable to provide timely BDA, the intelligence community began to accept and use it.[149]

The intelligence community needs to recognize and exploit the full potential of attack aircraft onboard video recording devices. For example, an attack package of 24 aircraft can record 24 separate video tape recordings of not only the target area but virtually any other point of interest between takeoff and landing. That is an enormous amount of combat information, which we essentially overlooked in Desert Storm. Much of the video available for analysis was vastly underutilized. We have only scratched the surface of what onboard video can offer to the intelligence process.

Also, there is now a significant distinction between an intelligence debriefer and a targeteer/analyst. This distinction is expressed in the following excerpt from AFP 200-17, *An Introduction to Air Force Targeting:*

> Although unit targeting personnel do not generally debrief crews after mission completion, they do provide the intelligence debriefers with the majority of the materials they need to accomplish this task. These materials may include charts, maps, statements of target significance, and target location. In addition, targeteers may provide specific essential elements of information to aid the debriefers in questioning the crews and obtaining initial bomb damage assessment inputs.[150]

Note the above extract does not mention analyzing onboard recordings or the exploitation/dissemination of inflight-derived information. Intelligence personnel should be trained to analyze and exploit intelligence information derived through unit-level onboard video recordings.

Aircrews should also be schooled in video assessment. Units in Desert Storm relied heavily on aircrews to review and assess their own onboard video recordings. Acquiring BDA is a "complex problem and is a classic intelligence and operations integration challenge."[151] Daily training missions should routinely be reviewed jointly by operations and intelligence personnel. AFM 3-I recommends that commanders take a more active BDA role.

> Evaluations by users should focus on insuring intelligence is useful, relevant, and timely for combat operations. These evaluations should address the value of the various types of intelligence products; responsiveness of the intelligence products to the user in terms of utility, timeliness, accuracy, and reliability; methods by which commanders can use intelligence better; and changes to intelligence products to better satisfy the user's needs.[152]

The BDA and intelligence acquisition processes must include a greater role for onboard video in future conflicts. Without it, draft AFM 3-I requirements for timeliness, accuracy, and utility most likely cannot be met.[153] BDA should be reported and disseminated in the shortest possible time to provide a basis for responsive combat decisions.[154] With the tempo and pace of modern combat, decision makers cannot afford to wait for the resolution of a competing analysis or they will waste sorties and needlessly endanger aircrew.

Video Joint Munitions Effectiveness Manual Weighting

> *Schwarzkopf complained that intelligence agencies had been unduly conservative in estimating how badly Iraq's military had been damaged during six weeks of intensive aerial bombing.*
>
> —*Congressional Quarterly Weekly Report*

General Schwarzkopf testified at a June 1991 Senate Armed Services Committee hearing,

> I would tell you, very candidly, that based upon some of the analysis that we were getting, we'd still be sitting over there waiting if we were dependent upon that analysis. Because unless it could be seen on a photo as absolutely 100 percent being destroyed, no credit was given for it being destroyed.[155]

Additionally, he expressed the need for an intelligence "methodology to incorporate both empirical measurement and subjective analysis as well as better fusion of operational, targeting, and intelligence information."[156] One of the areas he was referring to was mobile or battlefield target damage levels, which relied heavily upon attack aircraft video assessments. However, operations and intelligence personnel were not prepared to assess onboard video recordings analytically. Since this method of analysis was unexpected, they did not have an established method of determining weighting or probability of kill (PK) for attack video. Each echelon developed an "ad hoc" qualification to

video-assessed attrition counts for tanks and artillery.[157] However, methodologies were not universally accepted and the resulting diversity of assessments caused a considerable amount of "contentiousness" between the services.[158] For example, ARCENT unilaterally "established procedures that credited one third of the kills reported by pilot debriefs, one half of those estimated by video recorders, and 100 percent of the kills estimated by photo interpreters from all-source imagery."[159]

While we have video assessment procedures for air-to-air training, we do not have corresponding guidelines for air-to-ground. A Joint Munitions Effectiveness Manual (JMEM) methodology for weighting onboard video-assessed results must be developed. Since Desert Storm commanders relied upon onboard video-derived attrition counts, it is imperative commanders are provided an accurate decision-making tool.[160]

Enhance 51-Series Training

Draft AFM 3-I states that our military operation principles should "avoid the error of addressing either operations or intelligence as having distinctly separate wartime and peacetime concepts."[161] Unfortunately, bomb damage assessment frequently falls into this category because it is not easy to exercise in peacetime.

As mentioned earlier, we ingrained the need to score aircrew gunnery externally during Red Flag training, semiannual weapons qualification, and other independent scoring methods such as radar bomb scoring (RBS) sites. Consequently, we became reliant on peacetime scoring systems, reinforced the training aspects of onboard video, and overlooked fielding other onboard recording devices. Additionally, because onboard video recordings were considered primarily for training, the operations community did not stress the involvement of intelligence personnel in postmission video review and analysis.

During Desert Storm, unit commanders found themselves needing a unit-level BDA capability. Little emphasis had been placed on the importance of unit-level combat assessment for many years. BDA acquisition, reporting, and processing had been slighte ' in daily training, exercises, and evaluations.[162] Essentially, the unit-level BDA process had become extinct. Additionally, Desert Storm clearly proved that simple "hit or miss" mission reporting is no longer adequate. Postmission assessments needed to be much more detailed and precise.[163]

Commanders recognize that they need timely BDA to make their organizations effective in combat.[164] They must critically evaluate whether their intelligence can provide timely attack nominations.[165] Commanders must consider all their wartime BDA requirements and then realistically exercise during peacetime. The US Army believes that

> realistic exercise play is needed to polish BDA skills learned in formal training. It should be used to validate BDA procedures, ADP [automatic data processing] systems application, relevance to the operations and intelligence cycles, reporting methods and channels, communications connectivity, and the use of real-world

> intelligence collection assets and information. National, theater and tactical elements must be proactive in BDA collection, analysis and reporting.[166]

Another training aspect that would have significantly helped postconflict assessment is the preservation of each mission on videotape. Our 51-series manuals provide little BDA training guidance beyond tape titling. With the two previously mentioned exceptions, units did not meticulously title or preserve their tapes during the war. If all units had just annotated (with mission number, weapons load, and fuzing) and preserved their videotapes, postwar combat assessment would not be a problem today.

While the BDA process evolved during Desert Storm, it still needs refinement and subsequent institutionalization to ensure an effective process for the next conflict.[167] It should be exercised on a regular basis to minimize the unpredictable aspects that arise in combat such as weather.[168] The BDA system should be

> enhanced through a continual exchange of data in realistic training and exercise scenarios. BDA analysts must be comfortable with their service counterparts' equipment, terminology and procedures, as well as national and theater collection system capabilities. Procedures for transmitting BDA information to and from tactical, theater, and national levels must be practiced to ensure timely and accurate analysis is rapidly distributed to the appropriate warfighting elements.[169]

Even if national assets promised greater support in future conflicts, there is a compelling reason to develop a greater organic capability for combat intelligence and BDA.

> [A] collection system also needs redundancy so the loss or failure of one collection asset is compensated by like or different assets capable of answering the intelligence need.[170]

Revise MISREP Procedures

General Horner stated after the war that the key factors in producing a viable ATO are timely and accurate intelligence.[171] The intelligence cycle must be synchronized with mission reporting to ensure economy of force.[172] However, as discussed previously, the BDA process was unable to keep pace with the quantity and tempo of operations in Desert Storm. Consequently, decision makers began to rely upon onboard video to determine restrike requirements and follow-on tasking. The US Army white paper on BDA, recognizing the contributions of onboard video made during the Gulf War, recommended modifying the MISREP process to have the first restrike nomination be the result of attack aircraft onboard video reviews.[173]

The MISREP was intended to provide timely reports of "significant mission results and intelligence information obtained during debriefing."[174] Additionally, it was intended to document munition-specific information required to conduct follow-on analysis. During Desert Storm it did not accomplish either of these functions very well. MISREPs need to be far more detailed to facilitate BDA determination and postconflict weapons assessments.

There is also a doctrinal problem with our targeting and weaponeering process. Planners delegated most of the detailed mission planning to the wing or unit level.[175] This meant combat units had more latitude in selecting specific attack aim points, munitions, fuzing, and delay elements.[176] Unfortunately, this latitude contributed to the BDA analysis problems experienced during the war.[177] Because we no longer specify the weapon and fuzing on the ATO, external analysts do not know what to look for. Additionally, information derived in-theater, such as actual impact points, munition expended, and fuzing utilized was also frequently not available to support external imagery analysis. For example, imagery analysts typically did not know the specific aim points on a given airfield.[178] Consequently, not being privy to key information degraded accuracy and slowed the BDA process.

The MISREP format needs refinement, which includes giving a proper consideration to attack aircraft onboard video recording products. Second, units must realistically exercise with the volume of BDA expected in today's tempo of operations. Third, to be able to satisfy postconflict weapons assessment, weapons data and munitions impact points must be included in the postmission reporting process.

Joint Applicability/Integration

> *The technological revolution over the past two decades in both warfare and intelligence collection has changed the modern battlefield. These changes, combined with the revitalized emphasis on joint and combined warfare, require a more encompassing view of BDA doctrine and accompanying process and procedures.*
>
> —US Army BDA White Paper

Onboard video issues are a concern not only of the Air Force, but all services. For example, the Army recently fielded a number of systems with an onboard video recording capability. During the war,

> the Apache [helicopter] not only provided current combat information, but also recorded information for future intelligence analysis. Television cameras and infrared image collectors were mounted on the nose of the attack [helicopters].[179]

The Pioneer unmanned aerial vehicle also made its US debut during Desert Storm. Its onboard video products will require some of the same analysis skills as attack aircraft video. Onboard video commonality, assessment, and retransmission is a joint issue. As a result, there is a growing need in all services for video imagery assessment procedures and skills.

Cost-Effectiveness

> *Timely and accurate bomb damage assessment (BDA) capabilities are critical to the air campaign planning process since they provide the necessary information guiding decisions on the needs for target re-strike. To the maximum extent practical, valuable aircrew, aircraft, and weapon resources must not be risked or expended on missions against targets that have previously been destroyed.*
>
> —Desert Storm Strategic Air Campaign

As US forces become leaner, we must find ways to be more effective in combat operations without generating the need for more support assets.[180] Additionally, we cannot realistically expect to see any significant increase in the number of reconnaissance platforms to solve BDA problems after a highly successful Desert Storm military campaign.[181]

> Increasing the use of satellite data may lead to requirements for additional satellites and associated equipment, which could add enormously to intelligence costs.[182]

Even if we did field additional reconnaissance assets, they would not necessarily be under the control of war-fighting commanders.[183] National assets work on competing priorities and the number of targets covered at any one time is limited.[184] The availability of national assets to military commanders will continue to be an issue as seen by the bias in the following Congressional Research Service Report extract:

> It has become possible for field commanders to receive virtually real-time satellite tracking direct to a local readout device rather than from a Washington or even theater-level processing and analysis center. The successful use of such data in the Persian Gulf War may lead to demands for its availability in future contingencies.[185]

Any systems fielded to correct Desert Storm BDA problems must be readily available to war fighters, responsive, and affordable. Onboard video has all those qualities. Additionally, a larger role for onboard attack aircraft video in the BDA process would alleviate a significant amount of the overtasking of national and theater reconnaissance systems. An increased organic BDA capability is also highly desirable for tactical operations, particularly during times of fog and friction.[186]

> Air Force units should be organized to enhance self-defense capabilities and self-sufficient operations. . . . Both units and bases should be organized so they can operate autonomously for limited periods.[187]

Enhancing onboard video's role in the BDA and intelligence processes is largely only procedural. Better procedures and regulation guidance would be a highly cost-effective improvement to the BDA and intelligence processes, particularly when compared to the price of just one additional satellite.

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Chapter 4

Potential Aircraft Enhancements

After Desert Storm, Gen Norman Schwarzkopf "called for more equipment that would permit commanders in the field to collect detailed intelligence about specific targets on short notice."[1]

> Areas in need of improvement or the development of enhanced capabilities include tactical imagery collection, imagery retransmission, munitions effects assessments, weapons impact recorders, and . . . multi-spectral imaging.[2]

While there is no question that fast and accurate BDA will optimize scarce resources and save aircrew lives, the question is how to achieve timely BDA in a cost-effective manner.[3]

As discussed in previous chapters, onboard video played a significant role in the Desert Storm BDA process. Its demonstrated capability warrants a closer examination of how it can be improved to provide more and better information. If a larger percentage of BDA requirements could be satisfied by fielding more capable onboard recording devices, then we would reduce the tasking on theater and national reconnaissance assets.[4] Considering the price of today's reconnaissance platforms, improving onboard recording capabilities could be very cost-effective.

This chapter will explore general areas where potential aircraft modifications could enhance the intelligence and BDA processes.

Equip All Aircraft with In-flight Recording Devices

Secretary of Defense Dick Cheney strongly advocated deriving the greatest potential from the systems we have.[5] To achieve this goal,

> every strike aircraft and helicopter should be equipped with a system that video records mission data, including weapon[s] impact. Recorded data should have sufficient resolution and frame rate to enable precise determination of the point of weapon impact and to support BDA directly from the imagery.[6]

Equipping each attack aircraft with onboard recording devices enables planners and decision makers to have, as a minimum, BDA and intelligence information from each attack aircraft.[7]

Improve the Video Quality (Fidelity)

As previously discussed, many of the newer aircraft are already equipped with some type of video onboard recording system that makes data collection easier and more reliable.[8] During the war, onboard aircraft imagery proved itself in the F-117A stealth fighter, F-15E Strike Eagle, F-111s with Pave Tack, and F-16s with low-altitude navigation and targeting infrared for night (LANTIRN).[9] However, most of our current onboard video recording systems are not optimized for combat documentation. They were fielded primarily as training systems and have combat limitations. For example, the poor fidelity and reliability of F-15C video recorders resulted in a substantial loss of combat data.[10]

> The F-15 video tape recorder (VTR) was so unreliable, only about 30% of the air-to-air kills were documented on tape. Thus, it was difficult to determine with any certainty the missile engagement parameters and the corresponding results of each air-to-air engagement.[11]

As a result of the extremely poor quality of video recordings, the F-15 community is replacing its three-quarter-inch video reorders with an 8-millimeter (mm) system.

> The improved color cockpit TV system is a commercial off-the-shelf, latest state-of-the-art system, consisting of two micro-miniature video cameras with remote camera control units and two 8-mm recorders. This system is not affected by sunlight and records at low light levels at night with excellent video quality. Both the heads up display (HUD) and vertical situation display (VSD) are simultaneously recorded . . . [for] 120 minutes.[12]

The color recording ability of the new 8-mm system has major operation benefits.[13] It provides about "four times" the capability of the old black-and-white (BW) system for about one quarter the cost.[14] "There is no distortion of the pictures, any view can be expanded to the full size of the monitor on demand, and any/all video can be frozen."[15]

Over the years since the Vietnam War, the operational community has forgotten the combat utility of color recordings. A 1965 flight test determined that color film would significantly enhance the results of gun and strike cameras.[16] It said that "color film yielded superior results when compared to all the black and white film tested. In combat situations . . . and [for] documentary photography, the use of color film is highly recommended."[17]

The F-4D/E and F-111 gun camera systems were fielded color capable due to the emphasis color film received in Southeast Asia operations.[18] While color film was deemed essential for combat operations, the cost differential and additional processing requirements were expected to inhibit its routine use for daily training.[19] Many units continued to train periodically with color gun camera film throughout the 1980s.[20] Unfortunately, the combat advantages of color film was forgotten and video recording systems installed in line fighter aircraft were just black and white. Only our test aircraft were equipped with a color recording capability. A number of other countries have

fielded color onboard video recording systems. For example, even the vintage British Jaguar aircraft has a color recording capability our newest fighters lack.[21] Another feature of the 8-mm video system is the ability to time synchronize the playback of two video recordings (displays) with another aircraft's video recordings. This synchronization feature greatly enhances postmission analysis.[22]

Most of the test requirements to integrate an 8-mm color video system on A-7D/K, F-15A/B, and F-16A/B aircraft have already been accomplished by the Air National Guard/Air Force Reserve Test Center.[23] Serious consideration should be given to modifying all attack aircraft with a more capable recording system.[24]

Increase the Recording Time

Another important capability the 8-mm audio visual tape recorder (AVTR) system provides is the ability to record multiple sensor displays for up to two hours.[25] This remedies long-standing operator complaints about the short 30-minute length of the present three-quarter-inch system.

> The average F-16C/D Block 40 Lantirn mission significantly exceeded the 30 minute recording capability of the operational [3/4-inch] airborne video tape recorder (AVTR) system. The night LANTIRN training requirement [is] for a three-source AVTR system capable of synchronized play to assess heads up display (HUD) forward-looking infrared weapon-aiming, radar, and targeting pod employment.[26]

The standard 30-minute video tape length is inadequate for training or combat.[27]

Improve Video and Interoperability for All Services

The need to video equip all attack aircraft with an increased recording time, better fidelity, and color film is a joint concern. Rear Adm Mixson, commander of Carrier Group Two in the Red Sea, said during the Gulf War that

> the Navy is sorely lacking [a] state-of-the-art mission recorder, which not only provide[s] timely bomb-damage assessment and better training, but also good press coverage of targets struck. The A-6 in-flight forward-looking infrared recorder with two-inch format is a dinosaur and not conducive for training, bomb-damage assessment, or to meet public relations requirements. The F/A-18 recorder cannot be reproduced on three-quarter inch format except by recording off the aircraft's playback screen with a video camera. This makes it hard to obtain accurate bomb-damage assessment in most cases and extremely difficult to compete on television's Cable News Network with the other air forces.[28]

There is a definite need to standardize and improve onboard video recording capabilities of our attack aircraft.[29] The current three-quarter-inch video system needs to be replaced with a more capable system. As the F-15 program

manager recommended before the war, we should "procure and integrate an onboard recording device which provides for a high-high-fidelity, real-time, multi-sensor recording capability with minimum of two hours recording time."[30]

Improve Correlation

> *The Navstar Global Positioning System (GPS) system* "will revolutionize tactics in every warfare area."
>
> —Vincent Kiernan

The Gulf War saw the first widespread combat use of the global positioning system (GPS).[31] Lieutenant General Horner declared that GPS will "revolutionalize" future military operations.[32] Some combat aircraft, like the F-16, are already GPS equipped.

> They could overfly or mark target positions with the designator on their heads up displays (HUD), get accurate coordinates from their computers, and pass them on to bombers not equipped with GPS.[33]

The utility of onboard video could be significantly enhanced through the use of GPS data. Display recordings and, more specifically, sensor locations could be automatically tagged with GPS information, allowing accurate determination of sensor positions and bomb impacts.[34] Precise locations and times of impacts and en route points of interest would significantly aid the acquisition, analysis, and reporting of onboard video derived intelligence and BDA.

Employ Multispectral Imagery

> VTR imagery was very useful in Operation Desert Storm for providing BDA of PGM attacks. For the future, the resolution and overall capabilities of these sensors need to be improved to handle a variety of weapon delivery tactics at different flight levels. VTR for BDA should be provided to all attack aircraft. To obtain higher resolution, use of low-light-level, high-definition TV should be considered along with [infrared] IR systems.[35]

"From a BDA analyst's perspective 'a picture speaks a thousand words'."[36] Analysts frequently desire several images of a target taken from different perspectives, and if possible, by different sensors. Multispectral imagery contributes significantly to target damage assessments. Today's attack aircraft carry a variety of sensors to detect and attack targets. For example,

> Martin Marietta's target acquisition and designation sight/pilot night vision system [is deployed] on US Army AH-64A Apache helicopters. Symbology and imagery are presented to the pilot and copilot/gunner on an integrated helmet and display sight or cockpit [cathode ray tubes] CRTs, allowing the crew to locate and engage battlefield targets in day or night and under reduced-visibility conditions.[37]

Consideration should be given to enhancing onboard video systems with the ability to record in more than one medium.[38] A multispectral recording capability would significantly enhance the quality of onboard video recording assessments.[39]

Add a Dedicated Strike Camera System

Fiber optic cameras and advances in magnetic gimbal assemblies (or directional pointing devices) have made an updated strike video camera recording system feasible. Coupling a state-of-the-art camera, GPS data, and the ability to point camera rapidly and accurately, could make strike cameras a highly capable BDA and intelligence acquisition system.[40] Camera systems similar to those on UAVs could conceivably be readily adapted and installed on attack aircraft.[41]

> Mounted in each UAV from front to back was a forward-looking color TV camera, a color TV camera at a 45-degree downward angle, an infrared line scanner and a gimbal-mounted color TV camera with zoom lens. The gimballed camera could swivel 90 degrees and continuously observe a target as the UAV circled.[42]

Where the old Vietnam-vintage strike cameras suffered from stabilization problems as an aircraft maneuvered, newer systems can be space stabilized.[43]

A dedicated strike camera could automatically film points of interest along an aircraft's route of flight. Points of interest could be preprogrammed through flight planning systems like the mission support system (MSS).[44] Automating the process to alleviate the aircrew's work load is important. A pilot should not have to worry about filming en route points or his weapons effects while trying to evade enemy defenses.[45]

A rearward-capable strike camera system would have facilitated better BDA for those Desert Storm aircraft who delivered conventional munitions from medium and high altitudes. Additionally, it could have provided better feedback for deliveries of nonexplosive ordnance such as canisters containing leaflets.[46] A rearward-capable camera system would also be potentially worthwhile on other types of aircraft. For example, it could be useful on cargo aircraft for determining the location of air-dropped equipment or supplies.

While onboard video strike cameras may not have the fidelity of dedicated reconnaissance systems, technological advances have again made onboard recording systems a viable method of acquiring combat information and BDA.

Equip Aircraft with Onboard Review and Analysis Capability

The least payoff is when there is a big separation between the intelligence sensor and the guy who can do anything about the situation that is sensed.

Bruce A. Smith

"There are times when real-time targeting is not an issue to the commander and there are times where that is his only issue."[47] Targets on the dynamic modern battlefield require near real-time intelligence to accommodate effective use of air assets.[48] To facilitate rapid assessment, we should equip attack aircraft with an in-flight video playback/review capability. After attacking a target, an aircrew could review and assess mission results while on the return leg. This would provide the ability to pass timely attack results in flight to a controlling agency or home unit.

Imagery is rapidly becoming essential for communication, analysis, and targeting.[49] However, secondary dissemination of imagery in Desert Storm was deemed inadequate. General Horner testified to Congress, "I think certainly, right now much of our tactical intelligence rests on photo imagery, which you have to bring back, download, process, and then find some way to distribute it, usually manually or by another aircraft. There is no reason in our day and age that we cannot do that electronically and send it out."[50] In the future, onboard video-acquired information could be transferred while airborne. An aircraft onboard video playback and review system would be the precursor to an in-flight retransmission capability.[51] The ability to locate, review, and cue video imagery segments would be necessary in any future retransmission architecture. As a minimum, an onboard video playback and review system would speed follow-on targeting decisions and enhance the effectiveness of our forces.

Enhance Future Onboard Video Capability

Upgrading onboard video systems would be cost-effective, as they will remain a viable source of intelligence and BDA for the following reasons:

- First, even though high-tech munitions and weapon systems were the stars in Desert Storm, we may not be able to afford to have exclusively state-of-the-art munitions. Declining military budgets may require significant quantities of less sophisticated munitions to be kept in our inventory for some time.[52]
- Second, long-range unmanned systems like the Tomahawk may take priority for reconnaissance.[53]
- Third, with the proliferation of high-tech munitions, reconnaissance systems may not be able to operate for long periods of time near target areas. This could complicate the acquisition of sufficient imagery to assess all the targets attacked.
- Fourth, some of our advanced munitions have the capability to transmit the weapon's attack video to the host aircraft.[54] For example, the standoff land attack missile (SLAM) transmits an image of the target area back to the aircraft that launched the missile. The operator guides the missile with a joy stick to the target, recording the target area and the weapon's precise impact point.[55]

• Fifth, no other foe is likely to give us five months to deploy, acclimatize, and hone our skills.[56] We may have to fight our way into a theater. As a result, we could be dependent for some time on our organic onboard video for BDA.

So, in the future units may again find themselves in a situation similar to Desert Storm, with attack aircraft onboard video recordings as their only reliable source of timely BDA. Serious consideration should be given to enhancing the quality and capabilities of our attack aircraft onboard recording systems.[57]

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Chapter 5

Synopsis and Recommendations

While BDA is an art and not an exact science, it is still in our own best interests to make the process as accurate as possible.

--Capt John D. Jackson

Synopsis

Desert Storm clearly demonstrated we have bomb damage assessment problems. While the severity of deficiencies varied, unit-level war fighters considered the system "broke." Today's high-technology weapons require timely and accurate BDA to be used effectively and efficiently.[1] However, as we continue to improve the accuracy and lethality of our weapon systems, reconnaissance BDA requirements are likely to further increase. Unfortunately, we cannot realistically expect to see a significant addition of reconnaissance assets in the foreseeable future.[2] So, we need to make the fullest use of the forces we have.[3]

Attack aircraft onboard video was used extensively for BDA during the Gulf War. Often it provided BDA and intelligence not available through any other source. However, we have not properly institutionalized onboard video in either the BDA or intelligence processes. Operations-, intelligence-, and combat-camera organizations all need to integrate this capability fully into their war-fighting doctrine, tactics, operating procedures, and future requirements. Additionally, serious consideration should be given to improving existing onboard recording systems to further enhance the acquisition of BDA and intelligence.

We also need to be concerned with the growing size of support packages to conduct air operations. If we develop the need for support packages that are too large, relative to attack platforms, we risk having an impotent force.[4] To improve the ratio of shooters to support assets, we should field more capable onboard recording devices.[5] General Horner emphasized, "Anything that can't return intelligence immediately leaves you at a disadvantage."[6] He additionally stressed that even if we employ our most sophisticated and accurate weapon systems and cannot verify target destruction, we will need to expend additional resources to reattack the target.[7]

Desert Storm demonstrated that onboard video is a timely source of BDA.[8] While it will not replace the need for dedicated reconnaissance, onboard video offers a highly complementary source of BDA. When compared to the cost of

acquiring additional reconnaissance platforms, further enhancing onboard video is extremely cost-effective. Perhaps equally important, onboard attack aircraft recording devices represent an enormous intelligence acquisition potential by turning every attack aircraft into an intelligence collection platform.

Recommendations

Operations/Requirements—equip all attack aircraft with onboard video recording systems.

All attack aircraft should be capable of acquiring prestrike, en route, and poststrike imagery for intelligence and BDA.

Combat Camera/Operations—revive the armament recording program.

We need a comprehensive single-source document to specify unit-level BDA procedures. It should also delineate procedures for:

- video BDA acquisition/assessment/analysis/reporting,
- video archiving,
- video sanitization,
- video declassification,
- media releases,
- standardization of aircraft video equipment,
- requirements for unit playback/editing equipment,
- postconflict assessment,
- combat videotape libraries,
- (WRM) videotapes,
- wartime combat-camera support/manning, and
- VTR system maintenance/repair.

Combat Camera/Operations—establish onboard recording and playback system(s) oversight responsibilities.

A single agency should be responsible for:

- onboard video imagery/system standardization,
- video imagery duplication/reproduction,
- video imagery retransmission,
- videotape archiving,
- playback equipment requirements,
- playback equipment maintenance/repair, and
- joint/combined video system interoperability.

Intelligence—institutionalize attack aircraft onboard video in the BDA and intelligence processes.

Intelligence doctrine, regulations, and procedures need to address:

- training intelligence personnel in onboard video assessment/analysis,
- procedures/criteria for onboard video DMPI determination/reporting,
- procedures for onboard video precision guided munition analysis,
- procedures for onboard video HUD/sensor mobile target assessment,
- availability of video-derived data for BDA analysts,
- onboard video-derived MISREP data,
- lack of weapons data specified in the ATO/MISREP,
- procedures for onboard video intelligence acquisition/assessment/analysis/reporting,
- procedures for onboard video sensor recordings of en route points/targets of interest,
- manning requirements for assessing/exploiting unit-level onboard video,
- onboard video intelligence libraries,
- reflecting the appropriate value/weighting of onboard video results/products,
- video probability-of-kill (PK) weightings, and
- realistic exercises/evaluations for unit-derived intelligence/BDA.

Intelligence/Operations—establish joint munitions effectiveness manual (JMEM) weighting(s) and assessment procedures for onboard video products.

Establish mobile and fixed target PK weightings, damage criteria, and assessment caveats.

Operations/Intelligence—realistically train and evaluate combat assessment.

Also develop/establish procedures for:

- pre/postmission tape titling/labelling/documentation,
- video archiving,
- documenting weapons delivery parameters/fuzing/delay elements,
- BDA/intelligence acquisition/tactics,
- reporting video derived BDA,
- exploiting onboard video acquired intelligence,
- training aircrew/intelligence personnel to assess onboard video recordings,
- exercising/evaluating realistic BDA, and
- exercising/evaluating follow-on combat assessment.

Operations/Requirements—enhance existing onboard video systems.

We should establish/field:

- in-flight video recording playback/review system,
- color recording systems,
- increased video tape recording lengths (time),
- simultaneous recording of multiple sensors/displays,
- GPS tagged video displays/ground sensor locations, and
- improved video displays/film quality.

Operations/Requirements—explore additional onboard recording capabilities.

Investigate multispectral camera systems, independent strike/reconnaissance cameras, and in-flight transfer of onboard video imagery.

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Appendix A

DIA-Proposed BDA Terminology

Physical Damage Assessment (PDA). Addresses the question of, Was the target hit? If hit, Was the planned target element(s) damaged?

Operational Damage Assessment (ODA). Quantifies the ability of a single target to perform its intended mission, and assesses the functional damage to the target. This will also include estimating the recuperation time.

Target System Assessment (TSA). The functional damage assessment of a single target combined with the assessments of other targets that compose the target system. Evaluation of the overall impact and effectiveness of operations against the entire target system in light of the command objectives.

Munitions Effects Assessment (MEA). An analysis of the attack in terms of munitions effectiveness to determine and recommend changes to the methodology, tactics, fuzing, weapons system, or munitions selection to increase force effectiveness. MEA is conducted concurrently with the other BDA components.

Restrike Recommendation. Given the mission objective against the target and results of the TSA, a restrike recommendation addresses the question, Is reattack of the target necessary? What target element should be targeted?

Source: DIA/OGA 4 Message 041430Z May 1992, "Proposed Changes to Battle Damage Assessment Terminology."

Appendix B

Physical Damage Categories

Category	*Damage Description*
No damage	No observable damage
Damaged	Weapon penetration into facility
Partial	Collapse (1/3 of roof/side walls)
Destroyed	Greater than 1/3 roof/side wall collapsed

Notes:

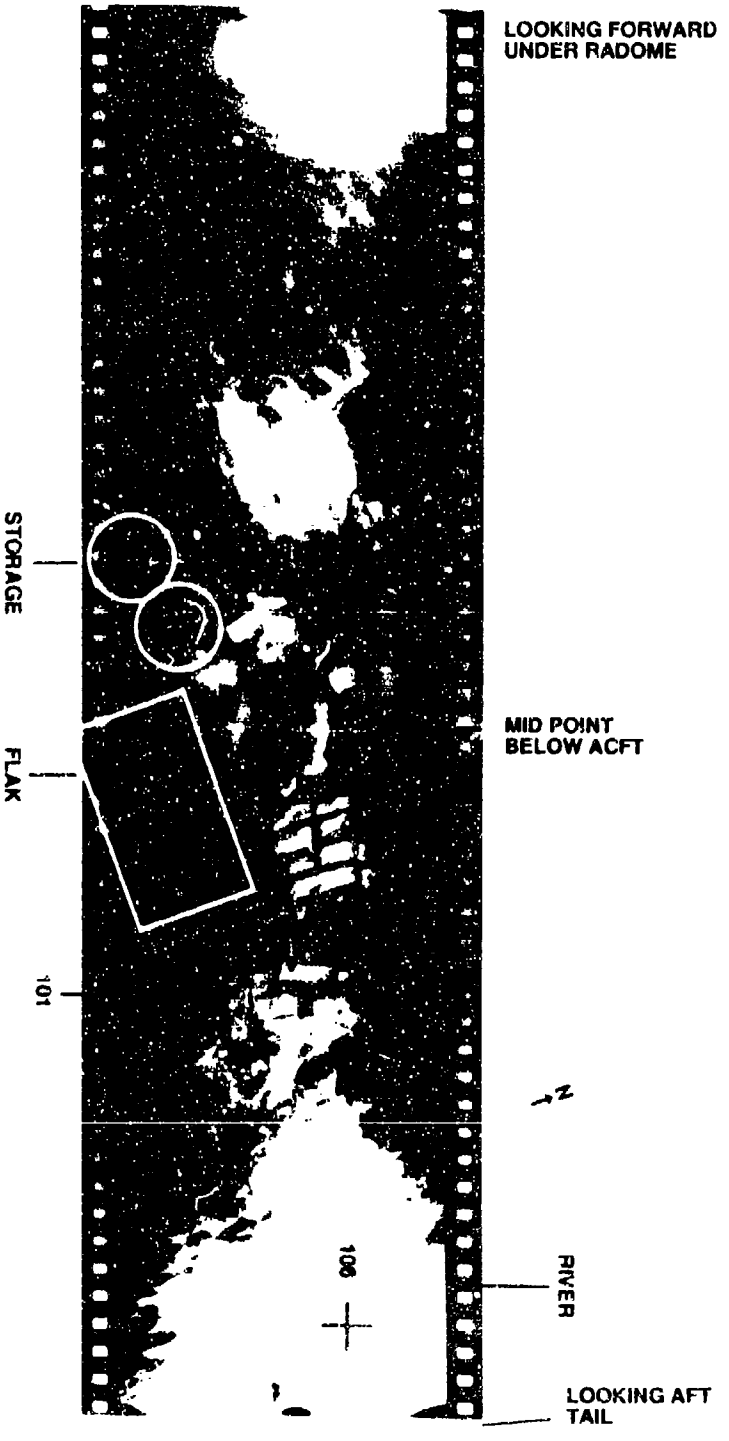
1. Evidence of successful weapon penetration could include entrance doors blown off, burn marks outside entrances, and/or venting of smoke (caused by fire or secondary explosions) out the doors. Analysis of aircraft cockpit video is essential to the assessment process of hardened facilities. The venting of weapon blast energy through doors and ventilation shafts can be readily seen only on video.

2. A hardened facility is designed to protect the enclosed function or equipment. A partial collapse or destruction of the facility is not always required to destroy the contents. The greater the extent of physical damage to the facility, the greater the recuperation time.

Source: HQ USAF/INAX, "Report on DIA Battle Damage Assessment Working Group May 92," 13 May 1992.

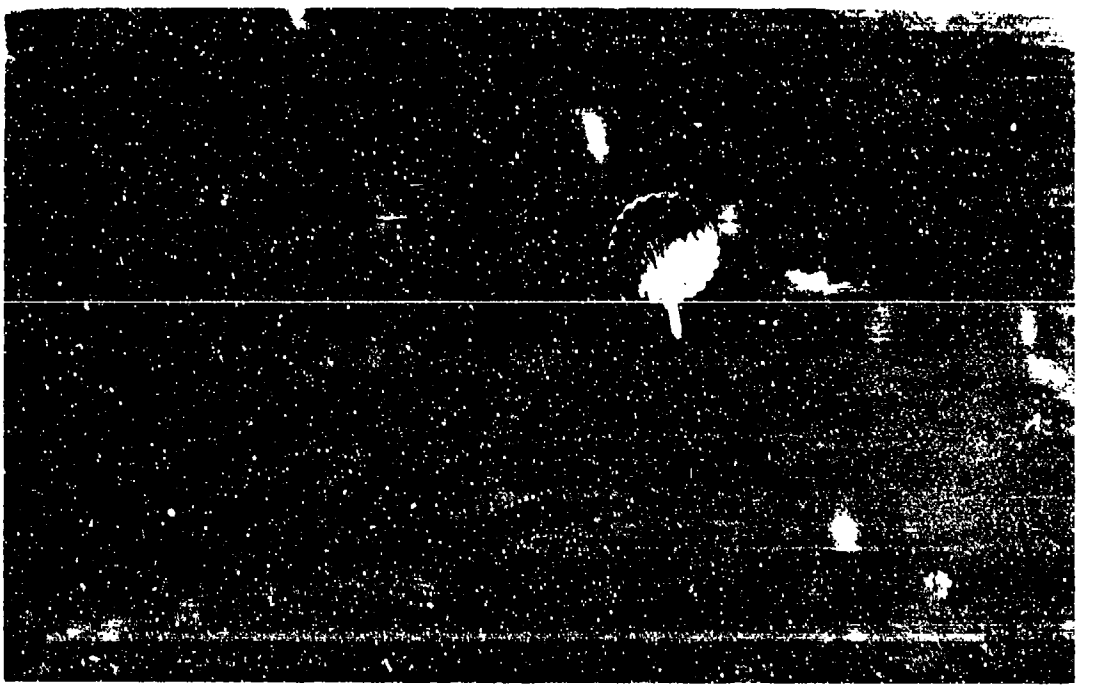
Appendix C

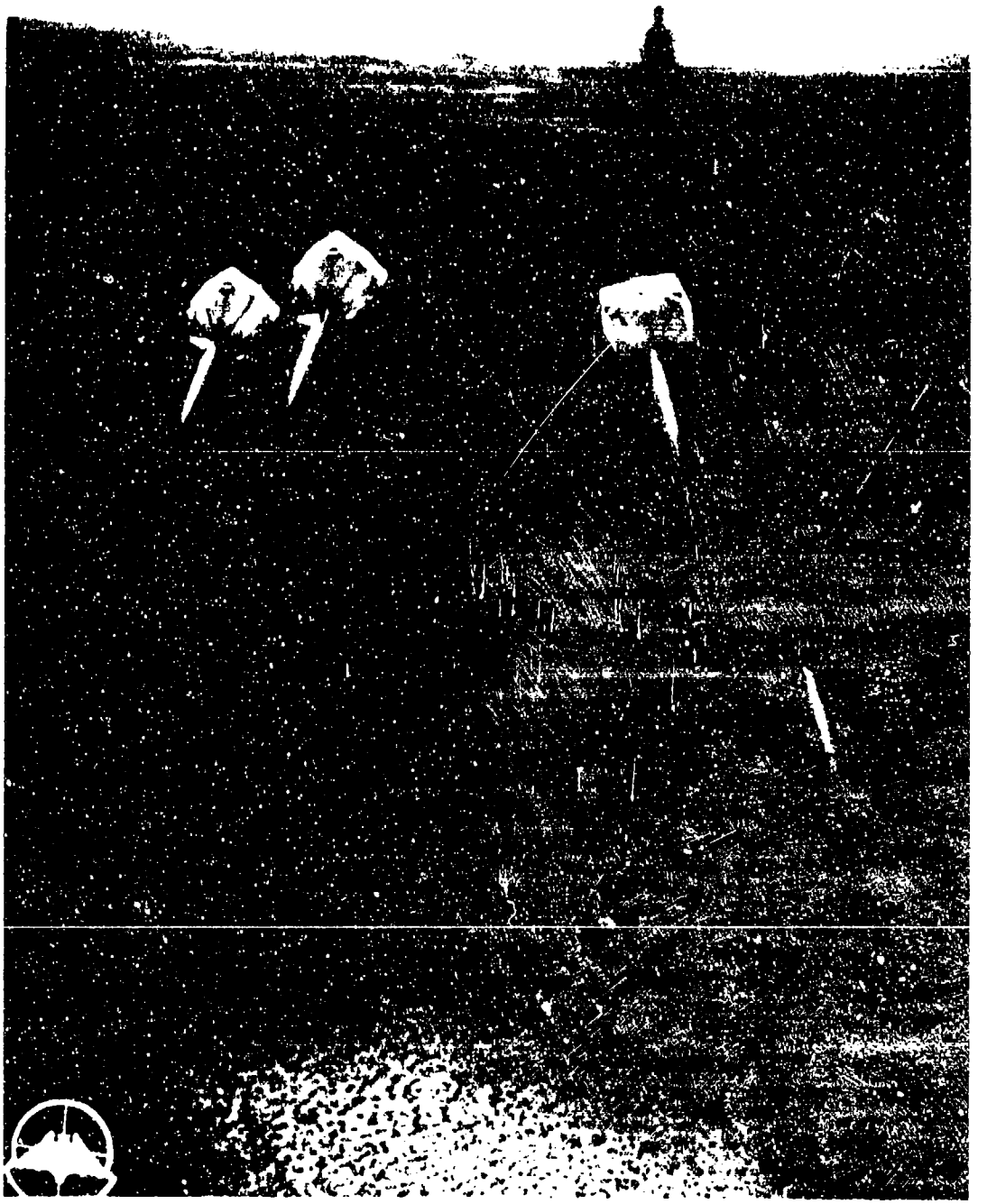
F-105 Vietnam St ike



Appendix D

Photos of F-111F Strike





Appendix E

F-15E Initial BDA Worksheet

SECRET (WHEN FILLED IN)

HAVE YOU ANY SIGNIFICANT INTEL THAT WE SHOULD PASS TO OTHER AIRCREWS IMMEDIATELY?

(AA/AG) MISSION #_____ TGT IDENTIFIER _____

TGT LOCATION _____ TGT TYPE _____ EQUIPMENT TYPE _____

LESDT ____ TARWI _____ TOT _____ ORDNANCE ____ QUANTITY _____

% OF TGT DAMAGED ___ % OF TGT DEST ____ % OF TGT COVERED ___

(AA) DEPARTURE BASE _____ TIME OF DEPARTURE _____

TIME ON STATION _____Z. TIME OFF STATION _____Z.

1. (AA/AG) (SURFACE TO AIR FIRE) WPN TYPE _____

WPN LOCATION _____ WPN ALT _____

YOUR LOCATION _____ YOUR ALT _____

INTENSITY OF AAA: HVY LT MED QUANTITY OF SAMS _____

SAM/AAA MISS POSITION _____ RWR _____

EVASIVE ACTION TAKEN (Y) (N) DTG OF EVENT _____

2. (SURFACE TO AIR FIRE) WPN TYPE _____

WPN LOCATION _____ WPN ALT _____

YOUR LOCATION _____ YOUR ALT _____

INTENSITY OF AAA: HVY LT MED QUANTITY OF SAMS _____

SAM/AAA MISS POSITION _____ RWR _____

EVASIVE ACTION TAKEN (Y) (N) DTG OF EVENT _____

DISC: #15
ID: 01200-10F

SECRET (when filled in)

NARR: (INCL SIGHTING OF MISSILE, TYPE CONTRAIL, COLOR PLUME, AND SPECIFIC COUNTER TACTICS USED.)

_____

_____

_____

_____

1. (AIR INTERCEPT) DTG _____ LOCATION _____

ACFT NAME _____ # OF ACFT ENGAGED _____

CONFIRMED DEST _____ # ACFT DAMAGED _____

ENEMY ACFT ALT _____ HEADING _____ SPEED_____

YOUR ALT _____ HEADING _____ SPEED_____

2. (AIR INTERCEPT) DTG _____ LOCATION _____

ACFT NAME _____ # OF ACFT ENGAGED _____

CONFIRMED DEST _____ # DAMAGED _____

ENEMY ACFT ALT _____ HEADING _____ SPEED_____

YOUR ALT _____ HEADING _____ SPEED_____

AMPN (INCLUDE TACTICS, CNTR-TACTICS, WPNS YOU EMPLOYED, ANYTHING UNUSUAL ABOUT ENEMY ACFT, WPNS LOAD, ETC.)

_____

_____

_____

_____

DISC: #15
ID: 01200-10G

USE THIS SPACE OR OTHER SIDE TO DIAGRAM INTERCEPTS 1ST

USE THIS SPACE OR OTHER SIDE TO DIAGRAM INTERCEPTS 2ND

(AA/AG) (AIRCRAFT LOST) ACFT NAME _____

OF ACFT LOST _____ REMARKS (INCLUDE CAUSE OF LOSS, CREW STATUS, DTG, LOCATION, ACTUAL OR ESTIMATED)

_____

_____

_____

_____

REMARKS (INCL ANY COMMANDER'S NOTES, ANYTHING WHICH MAY BE OF IMPORTANCE)

_____

_____

_____

DISC #15
TD 6200-10C

Appendix F

F-15E Revised BDA Worksheet

SECRET (when filled in)

SQUADRON _____ CALLSIGN _____ ACFT TYPE _____ # OF ACFT_____

SIGNIFICANT INTEL THAT SHOULD BE PASSED IMMEDIATELY

_____

_____

_____

MSN # _____ TGT LOCATION _____

TGT NAME _____ BE #

TARWI _____ TOT _____ ORDNANCE _____ QUANTITY _____

MISSION RESULTS _____

EN ROUTE OBSERVATIONS _____

_____

_____

_____

_____

TGT OBSERVATIONS _____

_____

_____

_____

_____

SECRET (when filled in)

TGT MATERIALS AVAILABLE: Y N

QUALITY/TIMELINESS OF AVAILABLE TGT MATERIALS _____

_____

_____

NARRATIVE _____

_____

_____

_____

DEBRIEFER: _____

Appendix G

Proposed Joint Battle Damage Assessment Terminology

Combat Assessment (CA). The determination of the overall effectiveness of force employment during military operations (including counternarcotics and insurgency to nuclear war). CA is composed of three major components, Battle Damage Assessment, Munitions Effects Assessment, and Reattack Recommendation. The objective of CA is to identify recommendations for the course of future military operations.

Battle Damage Assessment (BDA). The timely and accurate estimate of damage resulting from the application of military force, either lethal or nonlethal, against an objective. BDA can be applied to the employment of all types of weapon systems (air, ground, naval, and special forces weapon systems) throughout the spectrum of conflict. BDA is primarily an intelligence responsibility with required inputs and coordination from operations. BDA is composed of physical damage assessment, functional damage assessment, and target system assessment.

Physical Damage Assessment. The estimate of the quantitative extent of physical damage (through munitions blast, fragmentation, and/or fire damage effects) to a target resulting from the application of military force. This assessment is based upon observed or interpreted damage. Collateral and additional damage are also assessed in this process.

Functional Damage Assessment. The estimate of the effect of military force to degrade/destroy the functional or operational capability of the target to perform its intended mission, and the level of success of the force applied relative to the operational objective established against the target. This assessment is inferred based upon all-source information, and includes estimation of the time required for recuperation or replacement of the target function.

Target System Assessment. The broad assessment of the overall impact and effectiveness of the full spectrum of military force applied against the operation of an enemy target system or total combat effectiveness (including significant subdivisions of the system) relative to the operational objectives established.

Munitions Effects Assessment (MEA). Conducted concurrently and interactively with BDA, the assessment of the military force applied in terms of the weapon systems and munitions effectiveness to determine and recommend any required changes to the methodology, tactics, weapon systems, munitions, and/or weapon delivery parameters to increase force effectiveness. MEA is primarily the responsibility of operations with required inputs and coordination from the intelligence community.

Reattack Recommendation. Addresses operational objectives relative to the target, target critical elements, target systems, and enemy combat forces. Considers the level to which operational objectives have been achieved incorporating target/aimpoint selection, attack timing, tactics, and weapon systems and munitions. Addresses results of the BDA and MEA analysis and offers reattack and other recommendations as a function of the target nomination/development process. These recommendations are made from both the operational and intelligence communities.

Source: DIA/DIW 4A/B Approved Battle Damage Assessment (BDA) Terminology

We welcome your comments on this research report or opinions on the subject matter. Mail them to: CADRE/RI, 401 Chennault Circle, Maxwell AFB AL 36112-6428.

Cockpit Video

A Low Cost BDA Source

Smith